PERU HEALTHY KITCHEN/HEALTHY STOVE PILOT PROJECT

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ACRONYMS

ARI	Acute Respiratory Infection
ALRI	Acute Lower Respiratory Infection
CEPIS	Center for Sanitary Engineering and Environmental Sciences
CO	Carbon Monoxide
COPD	Chronic Obstructive Pulmonary Disease
EAQ	Peru’s National Environmental Air Quality Standards; also ECA (Spanish)
ECO	Centro de Ecología y Género (Centro ECO)
EHA	Environmental Health Association (“Association”)
EHC	Environmental Health Committee (“Committee”)
ETHOS	Engineers in Technical and Humanitarian Opportunities of Services
GTZ	German Technical Cooperation
IAP	Indoor Air Pollution
NGO	Non-governmental Organization
PAHO	Pan American Health Organization
PM	Particulate Matter
USAID	United States Agency for International Development

EXECUTIVE SUMMARY

Most rural indigenous people of Latin America live in poverty in communities that rely heavily on biomass and other solid fuels for cooking and heating. Communities at higher elevations in particular are often exposed to severe levels of indoor smoke from inefficient burning of fuels in open fires or rudimentary stoves in poorly ventilated spaces. Exposure to indoor air pollution (IAP) poses a serious health risk of respiratory infection, causing illness and even death for those who spend the most time in the home cooking environment, namely women and children.

Beginning in 2003, the energy team of USAID's Bureau for Economic Growth, Agriculture, and Trade, and the environmental health team of the Bureau for Global Health jointly supported a cooperative agreement with Winrock International to develop models to reduce indoor air pollution by combining fuel-efficient cooking technologies with behavior change messages and market-based distribution mechanisms. Winrock developed two project models: a peri-urban model piloted in Bangladesh for poor households and a rural model piloted in the highlands of Peru for indigenous communities.

Field implementation of the Peru "Healthy Kitchen/Healthy Stove" project was led by Centro ECO, a Peruvian NGO, in the rural district of Inkawasi in the northern department of Lambayeque, where 3,000 Quechua-speaking families live at 1,600 to 3,200 meters above sea level. The project involved 33 of the 60 communities in the district and aimed to significantly reduce IAP levels within the kitchens of participating households. It also aimed to establish a sustainable market for improved and appropriate stoves to avoid the need for subsidies, current or future, and ensure that stoves would be available to the villagers beyond the project period. Winrock coupled product promotion with a multi-faceted communication campaign to raise awareness about the risks of indoor smoke and to introduce improved stoves and specific behaviors as effective tools for reducing exposure.

The 21-month project resulted in community ownership and management of the production, promotion, micro-financing, and broad dissemination of improved "Inkawasina" stoves. Environmental Health Committees (EHCs), composed of local leaders and trained promoters charged with educating the public about indoor smoke, improved stoves, and related behavior and environmental health issues, were created in each participating community. Geographic clusters of committees in turn formed three Environmental Health Associations (EHAs) to oversee and administer the micro-loan fund and to report progress and problems to Centro ECO.

A cadre of 33 promoters from the EHCs was trained to deliver messages directly to families using educational illustrations about the negative impacts of indoor smoke and the benefits and proper use and maintenance of improved stoves. Radio spots broadcast over a four-month period on a popular radio station reinforced these messages, and various print media were disseminated throughout the communities to raise awareness of the project and elicit participation. "Healthy Kitchen" competitions motivated participating families to take additional steps to create healthy and orderly kitchen environments.

To maximize access to the stoves, Winrock and Centro ECO developed an animal-based micro-loan system to reflect the region's reliance on barter to exchange goods and services. This was perhaps the most innovative aspect of the project. Despite some challenges in reconciling animal reproduction rates with anticipated repayment plans, the loan system has been largely successful. As of August 2007, 491 families had received their loan of an animal "module" (one male chicken or duck and five females, or one male guinea pig and 11 females). This loan represented 75% of the value of the stove, while the remaining 25% of the value was provided by the family in the form of homemade adobe bricks and labor. The family was then required to pay back 2.4 animal modules to cover the loan principal, the cost of the stove, and the EHA's administrative cost of project management, including technical assistance from project promoters.

This micro-loan system provided income for two new types of entrepreneurs: stove builders and ceramic "elbow" combustion chamber makers. A total of 27 entrepreneurs now get paid in animals or cash by the EHAs, which manage the loan fund.

By September 2007, improved stoves had been installed in 377 of the borrower households. An additional 36 families chose to purchase stoves with cash. Surveys and focus groups confirmed that the majority of families were happy with their stove's performance. The unexpected outright purchases, while still a small percentage of stove acquisitions, underscored the value that families place on having an improved stove.

People were happy with their stoves for a number of reasons, most notably the reduction in indoor smoke and the reduction in fuelwood consumption. Stove monitoring and user feedback showed that the Inkawasina stove was saving over a third of the wood previously used in open fires. Indoor air pollution (IAP) monitoring within 12 months of stove installation showed that indoor concentrations of respirable particulate matter (measured as PM_4) and carbon monoxide (CO) were reduced by more than 80% in a large majority of households. A second, post-intervention monitoring conducted up to 24 months after installation showed less dramatic reductions as well as significant increases in IAP levels, in some cases, revealing a possible weaknesses in the ceramic elbows and the need to reinforce messages about effective (and counter-productive) behaviors to sustain the substantial IAP reductions demonstrated by this intervention.

According to household surveys and focus group discussions with families and promoters, the majority of families in the district are now aware of the risks of IAP. Most of those who have acquired the Inkawasina stove have improved the ventilation of their kitchens by keeping doors and windows open while cooking. Some families have invested considerable time, materials, and ingenuity to build new, larger windows and install shelves to store utensils and food. Most families report they now try to keep children away from smoke as much as possible. The implementing team was surprised to discover that a large number of families spontaneously constructed new kitchen rooms in anticipation of receiving their new stoves. These kitchens were for the most part larger and better ventilated than the previous spaces. These families cited pride in their new clean cooking spaces, a dramatic departure from the previous soot-encrusted cooking areas.

While the results of this project have been largely positive, a small portion of families (estimated at about 3% of project participants) have experienced cracking and even collapse of the ceramic elbow combustion chamber, preventing them from using the stove. Of these families, some have fixed the stove while others, unfortunately, have abandoned it. Centro ECO and the promoter team are acutely aware of these problems and are actively seeking appropriate measures to remedy the situation and to reduce the likelihood of elbow cracks.

The overall positive results from this “Healthy Kitchen/Healthy Stove” project have stimulated other organizations to adopt one or more components of its approach. The German aid agency GTZ is using the Inkawasina stove in a 2,750-stove dissemination project in the Bolivian Andes and is focusing on standardized production of the ceramic elbow to improve quality. The Pan American Health Organization (PAHO) has used the IAP monitoring protocol near Cuzco to establish a baseline for a 3,000-stove dissemination project (using the same equipment from the USAID project, loaned to them for this purpose), and has adopted the same focus on local stove entrepreneur development. The SEMBRANDO initiative of Peru’s First Lady is using the Inkawasina stove and negotiating with Centro ECO to expand the project to include another 560 households in Inkawasi. SEMBRANDO’s ambitious goal is to provide 1 million families throughout the Andes region with stoves, latrines, and improved agricultural techniques over the next five years. While the animal-based micro-loan system has generated a great deal of interest and discussion among these groups and elsewhere in Peru, it remains to be seen whether any of these initiatives will adopt this type of market-based approach to ensure sustainable adoption of improved cooking technologies and practices.

I. PROJECT OVERVIEW

A. Background

1. Poverty, biomass, and smoke in high-Andean kitchens

Throughout Latin America most indigenous populations live in rural areas in conditions of extreme poverty. Their communities typically are located in remote, difficult to access areas with limited economic and social development. In countries such as Peru, Ecuador, Bolivia, Mexico, and Guatemala, indigenous populations comprise a significant portion of the total population. According to the Center for Sanitary Engineering and Environmental Sciences (CEPIS), a technical branch of the Pan American Health Organization (PAHO), the majority of indigenous populations in Latin America rely on biomass for cooking and heating.

A significant portion of Peru's indigenous population is exposed daily to heavy levels of cooking smoke in confined kitchen spaces with little ventilation. The situation is particularly severe at higher elevations where solid fuels are the only available options for cooking, and cold temperatures and windy conditions lead people to cook almost exclusively indoors. Daily exposure to high levels of indoor smoke represents a serious health risk for the millions of indigenous poor who inhabit the high Andes, particularly women and children, who typically spend the most time near the fire during meal preparation.

View of Incahuasi
Photo credit: Winrock International

Mortality rates for the under-five segment of the indigenous population are much higher than the national average; for the Andean populations targeted in this pilot, the rates are estimated in the range of 60-80 deaths per 1000 live births, up to twice the national average. According to the Ministry of Health, acute respiratory infection (ARI) was the leading cause of death in Peru in 2000, accounting for 9,753 cases or 12% of all reported deaths.[1] Acute lower respiratory infection (ALRI) among infants and young children, and chronic obstructive pulmonary disease (COPD) in adults, are estimated to be significant contributors to mortality and morbidity among Peru's indigenous peoples of the high Andes.

Peru's Country Environmental Analysis,[2] a recent study produced by the World Bank, ranks indoor air pollution (IAP) as the fifth most costly environmental degradation issue in the country, after water and sanitation, outdoor air pollution, natural disasters, and lead exposure. According to the study, the negative health impacts associated with IAP cost Peru about US$240 million annually. The report points out that child mortality and illness due to respiratory infections represent 34% and 32%, respectively, of this total cost, while death and illness of adults due to COPD and ARIs together represent 17% of the total cost.

The same report notes that IAP contributes to 25-40% of child ARI deaths in Peru; 20-30% of all ARI-related illness for children under five years of age; 15-25% of all ARI in adult females; and 20-40% of all cases of death and illness due to COPD.

2. The Ayamachay Pilot: 2003-2004

Although development agencies (private, governmental, and international) have implemented efforts to improve basic living conditions for Peru's indigenous populations by addressing the need for clean water and sanitation, IAP has not been part of the agenda. A unique pilot experience integrating improvements in water and sanitation while tackling IAP was undertaken in 2003 by PAHO and GTZ in the community of Ayamachay, in the district of Inkawasi, department of Lambayeque, in northern Peru. The initial focus of the project was limited to water and sanitation; however, the IAP levels observed in houses in Ayamachay were too severe to be ignored by PAHO and GTZ staff. Improved stoves were

Infants are usually present when cooking takes place in Inkawasi and are at high risk of ARI.
Photo credit: Winrock International

[1] With a 50% report rate. http://www.minsa.gob.pe/estadisticas/estadisticas/Mortalidad/092000DI00.htm

[2] Republic of Peru Environmental Sustainability: A Key to Poverty Reduction in Peru. Country Environmental Analysis. June 2007. Report 40190-PE, The World Bank.

thus incorporated into the pilot under the "environmental health" umbrella.

By 2004 the pilot initiative in Ayamachay had installed latrines, a running water system, and improved wood stoves in 60 households, addressing all basic needs of sanitation and cooking for these rural families. The Centro de Ecología y Género ("Centro ECO"), a local non-governmental organization (NGO) based in the city of Chiclayo, provided training in basic health and environmental issues to the Ayamachay community leaders. The improved wood stove was custom designed by a local engineer. He used mostly locally available materials to create a model that improved energy efficiency and curbed emissions, yet was appropriate and affordable to the community. Project monitoring conducted in 2004 revealed a 90% acceptance rate of the stoves by Ayamachay families, with reported reductions in respiratory illnesses among women cooks. Unfortunately, neither PAHO nor GTZ committed to expanding this experience within the region.

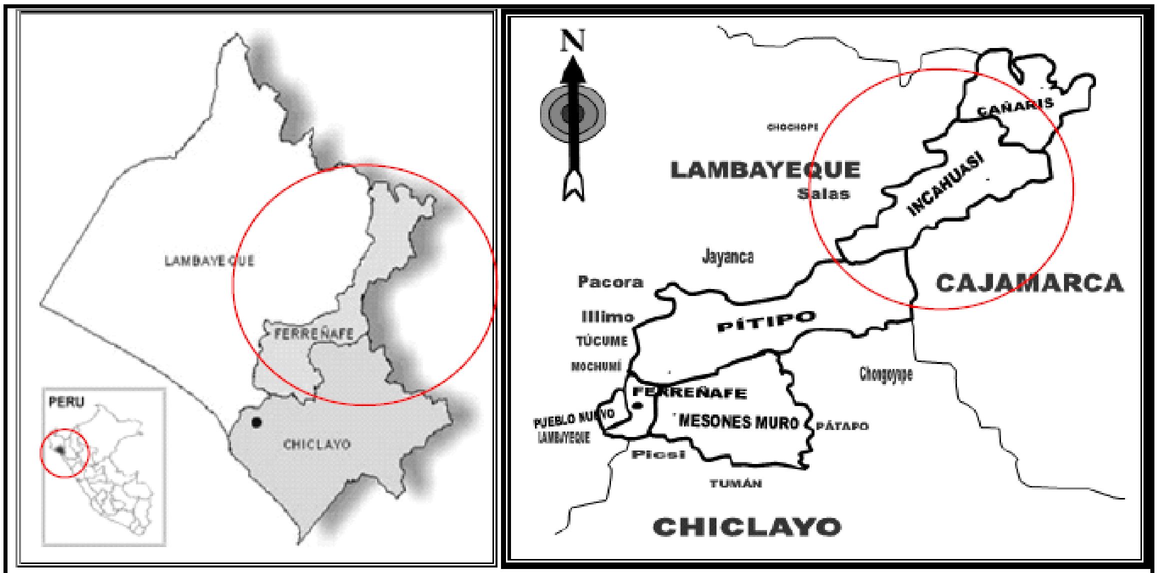
3. The Healthy Kitchen/Healthy Stove model: 2005-present

To strengthen this experience and further develop it into a replicable model, the energy team of the USAID Bureau for Economic Growth, Agriculture, and Trade and the environmental health team of the Bureau for Global Health jointly supported the "Healthy Kitchen/Healthy Stove"[3] pilot project on a district-wide scale. The project described in this report developed a unique model for the manufacture and distribution of improved wood stoves among poor rural indigenous communities; creating local organizational capacity for raising awareness about the health risks of indoor smoke among the families of 33 communities; producing and supplying the wood stove technology; and enabling widespread community access through an innovative finance scheme. This project model was developed to be easily coupled with water and sanitation and other environmental health initiatives. The lead field implementer for this project was Centro Eco, the NGO that participated in the previous project in Ayamachay. Centro ECO specializes in community development of environmental projects. Winrock International provided project design guidance, technical support, and administrative oversight on behalf of USAID.

The district of Inkawasi is located in the high-Andean mountains of northwestern Peru, northeast of the city of Ferreñafe within the department of Lambayeque (see maps on next page). It is an indigenous district with 60 villages (approximately 3,000 families) in a mountain landscape that ranges from 1,800 to 3,200 meters above sea level. Quechua is the primary language, with Spanish the secondary language. The economic activities are primarily agriculture based, including cultivation of wheat, potatoes, green peas, corn, timber, and animals such as cows, chickens, guinea pigs, and sheep. Houses typically are built of adobe, roads are unpaved, and electricity service is unreliable and reaches only a small portion of the population. Elementary schools are usually available throughout the

[3] "Cocinas" in Peru refers to both stoves and kitchens; thus "Cocinas Saludables" carries the double meaning of Healthy Stoves and Healthy Kitchens.

villages, while secondary-level schooling is available only in the town of Incahuasi.[4] There are health posts and public phones in the towns of Incahuasi and Uyurpampa.



Maps of Peru, highlighting the Inkawasi district

B. Project Objectives

The overarching objective of Healthy Kitchen/Healthy Stove pilot project was to reduce exposure to indoor air pollution among indigenous communities in the high-Andean region through an integrated and sustainable household energy intervention. Women and children were the primary targets, given their traditionally higher exposure to kitchen smoke.

The project aimed to develop a program model for replication elsewhere in Peru and throughout the Andean region, expanding the Ayamachay pilot from one community to at least 20 communities and 600 households in the district. The model also sought to complement the improved stove technology with behavior change communications, the establishment of community institutions, and an innovative finance mechanism to increase the project's sustainability.

C. Approach and Activities

The approach taken in this pilot project reflects a present-day understanding of the key elements needed to achieve and sustain adoption of improved technology and behavior change and, in this case, reduce exposure to indoor air pollution. Past interventions have yielded many lessons about the failure of one-size-fits-all, technology-driven "stove" programs to achieve long-term adoption. The greater challenge lies in demonstrating the

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[4] The district and a town within the district have the same name, which is commonly spelled two ways: Inkawasi and Incahuasi. In this report, Inkawasi refers to the district and Incahuasi to the town.

combination of elements most likely to be effective in the short term for a given population or category of populations—and most likely to be replicated and scaled up over the long term. This project demonstrates an integrated intervention composed of the following core components:

Local organizational infrastructure

Establish an organized cadre of promoters and other community leaders trained in the health risks of indoor air pollution, improved stove design and benefits, animal husbandry, and micro-loan management to ensure local capacity to carry on all aspects of the intervention beyond the life of the project. Building formal community structures facilitates initial community buy-in and ultimate ownership and responsibility for long-term results.

Awareness building and behavior change

Raise awareness within the target population and among neighboring families about: 1) the risks associated with exposure to indoor air pollution; and 2) technological and behavioral options to reduce exposure. Increased awareness and improved practices are revealed in attitudes and perceptions as reported through surveys, focus group discussions, and promoter feedback. Improved practices are assessed through IAP reductions (or lack thereof) and promoter observations of changes in kitchens.

Market development

Build the foundation for a sustainable market through the development of local stove entrepreneurs and a micro-loan mechanism that reflects the region's reliance on barter rather than cash for the exchange of goods and services. The selected stove technology is a locally adapted and accepted wood stove technology utilizing well-tested design principles for reducing fuelwood consumption and indoor air pollution while remaining cost effective.

Technology adoption

Distribute energy-saving, emissions-reducing cookstoves adapted to local conditions among a target population of 600 families, or 20% of Inkawasi households, across at least one-third of the district's 60 communities. This target goal of 20 villages was exceeded, and 33 villages ultimately were included in the project area. Successful adoption of the improved stove technology implies that families use the Inkawasina stove exclusively for daily cooking needs (using traditional open fires only *outdoors* for special events) and are satisfied with the new stove's performance. Winrock also promoted adoption of a locally adapted retained heat cooker, or "haybox," in a limited number of households based on the level of interest identified through initial trials.

Indoor air pollution monitoring

Verify changes in kitchen concentrations of respirable particulate matter (measured as PM_4) and carbon monoxide (CO), with a reduction target of 80%, in a representative sample of 30 households (5% of the target population).

Annex I presents detailed information on project indicators. The approach taken for each of these project components is discussed in the next sections.

1. *Establishing community-level organizational infrastructure*

Securing community ownership or buy-in and building community capacity to manage project components were fundamental steps in sustaining project activities over a long period. The project team agreed that in addition to developing technical and administrative capacity among individual promoters, a governing structure was needed to achieve near-term project objectives as well as the longer-term goals of a locally managed, market-based system.

Centro ECO applied its strong communications and organizational skills, along with its experience in community organization elsewhere in Lambayeque, to mobilize the communities of Inkawasi. These people- and time-intensive activities dominated the first few months of project implementation.

The model developed for Inkawasi involved two levels of organization:

1. **Community level**: Environmental Health Committees (EHCs) for each of the 33 participating villages. These local volunteer-based community organizations were responsible for promoting the project and coordinating implementation activities within each village. Winrock and ECO chose "environmental health" to characterize the committees, with the vision that the scope of their activities could broaden with time to encompass water and sanitation, hygiene, and related environmental health issues.
2. **Regional level**: Environmental Health Associations (EHAs) of EHCs grouped on a geographic basis. The 33 EHCs were divided among three EHAs to cover the wide territory. The EHAs were responsible for overall project administration, coordination, and reporting to Centro ECO.

Each committee is composed of four lead promoters trained in IAP health risks and the behavioral and technological solutions to mitigate them. The leaders include a President, Secretary, Treasurer, and substitute. Winrock urged committees to select women to hold at least one if not two of these posts. The overall mandate of the committees is to promote sound environmental health practices. While the emphasis of this project was IAP reduction, the scope of promoter training—and in turn their awareness-raising activities with target households—included more general kitchen organization and hygiene issues, under the umbrella of "Healthy Kitchen."

Committee members elect leaders to manage the associations. Each EHA is responsible for overseeing the work performed by EHCs within the association. The EHAs also approve EHC work plans, approve new families who want to join the project, and keep records on the number of animal modules delivered and recovered, stoves made, and other data, which is then shared with Centro ECO and the other two EHAs during their monthly joint planning meetings.

Figure 1 on the next page shows the organizational structure of the EHAs, EHCs, and Centro ECO, which worked with local leaders to form these community organizations before transferring overall project management responsibility to the EHAs.

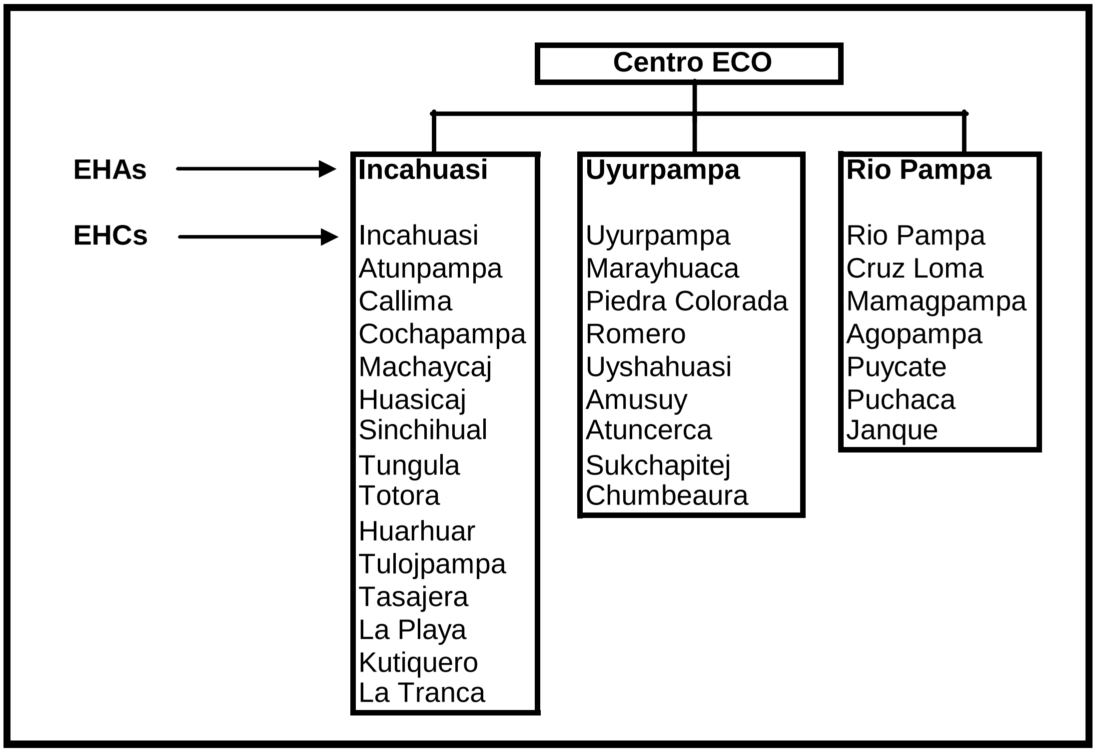

Figure 1. Organizational structure of EHAs and EHCs in the Inkawasi district

2. Raising awareness and promoting effective behaviors

The core mission of the Healthy Kitchen/Healthy Stove project was to raise awareness among the population of the Inkawasi district about the risks associated with exposure to IAP from the use of solid fuel for cooking, and to promote ways to mitigate these risks through improved behaviors and technologies. Local buy-in, knowledge, and communications capabilities were central to achieving this mission. Several activities engaged the population at the household, community, and municipal levels.

Project kick-off and broad-level promotion

A series of presentations was developed to inform local leaders of the project's objectives and seek their collaboration. First, Winrock's lead implementing partner, Centro ECO, made presentations to provincial authorities and opinion leaders in the city of Ferreñafe, followed by two local meetings with community leaders in the villages of Uyurpampa and Incahuasi. All of the local leaders expressed support for the project. To raise awareness about the project and its objectives among decision makers throughout the country, brochures were produced and distributed by Centro ECO staff at meetings and seminars throughout the region and in the capital city of Lima.

Message and material development

Winrock worked with Centro ECO to develop a range of communications materials for use by trained promoters when meeting directly with families or community groups, or for dissemination through a range of local media. All communications focused on three primary messages—a problem statement and two solutions—to be delivered jointly:

1. Smoke from indoor cooking fires causes serious respiratory illness, particularly among women and children, and can even cause death of children.
2. The Inkawasina stove enables a cleaner and healthier kitchen while reducing the use of fuelwood.
3. Improved kitchen practices, such as ventilation, keeping children away from smoke, and using dry fuelwood can help minimize the health risks of indoor smoke.

Because the Inkawasina stove had already been field tested in Ayamachay, it was promoted from the beginning of this project as a solution to the indoor smoke problem.

Specific materials were developed to encourage behavior change, including:

- Large banners and murals placed centrally in each village to raise awareness of the issues and publicize the project
- Smaller posters for broader distribution around the district, with similar objectives
- Flyers containing information on the project; health impacts of smoke; stove construction, use and maintenance; and animal care were circulated through the villages
- Radio spots featuring local women discussing health impacts of kitchen smoke and the benefits of an improved stove
- A set of illustrations conveying messages about the ill effects of smoke; indoor conditions resulting from an open fire versus an improved stove; images of a well-ventilated, orderly, and clean kitchen; and proper operation and maintenance of the stoves (shown at right). These materials were aimed at the end user and intended for use by promoters during initial awareness-raising meetings with families, and later to train them in the use of their new stoves.

Messages and graphic images were developed with help from local artists and feedback from focus groups. The materials used both Spanish and Quechua, as appropriate, and were culturally adapted for this high-Andean, Quechua population. An awareness campaign was launched with the hanging of large murals in each target community; displays of posters depicting key health and fuel-saving messages; and district-wide radio broadcasts of information and educational messages about IAP risks and project benefits. As local leaders were identified and trained as promoters, the direct awareness and promotion activities began through small group discussions and household visits.

Promoter selection and training

The project developed a cadre of local promoters to distribute information to families and lead the stove dissemination. Promoter responsibilities included making house visits and leading activities with groups of women at the local community centers to share knowledge about IAP risks, discuss the Healthy Kitchen/Healthy Stove project, and recruit participants.

Centro ECO was responsible for training the promoters, who were selected based on their interest in the project. The project team planned to train equal numbers of men and women as promoters, not only to achieve a gender balance, but because women were expected to be more effective at communicating health risks and stove benefits to other women. At least one promoter was trained in each community.

Healthy Kitchen competitions

At the recommendation of Centro ECO, a series of "Healthy Kitchen Competitions" was organized among families receiving the improved stoves. The competitions reinforced the concepts of clean air and kitchen cleanliness and provided additional incentives to natural leaders in the community to take pride in their kitchen environment and share their approaches with other women. A total of 22 competitions were held.

3. Promoting appropriate technology

The chosen technology for this project was an improved woodstove called the "Inkawasina" stove, developed by Centro ECO engineer José Humberto Bernilla. This stove was field tested by 60 households under a GTZ pilot with excellent results. From the project kick-off meetings with municipal and community leaders to the household-level promotion by community promoters, the Inkawasina stove was touted for its ability to reduce indoor smoke, reduce respiratory disease, and reduce the time and physical drudgery of collecting fuelwood. Based on community acceptance in the Ayamachay pilot, the model was deemed appropriate, with some small improvements, for immediate promotion.

In October 2007, after the project was completed, the GTZ program in Bolivia contracted Aprovecho Research Center to assess the performance of the Inkawasina stove, among many others to be promoted in Bolivia. Aprovecho had the following conclusion about the Inkawasina stove design: "The Inkawasi-based stoves are wonderful. Successful use of sunken pots in a chimney stove is the best way to reduce fuel use and IAP level in a home. The stove design is well done from a heat transfer and combustion efficiency standpoint, and they are appropriate solutions to local needs using local materials. Also the stoves fared quite well in all tests that were conducted." With reference to the Inkawasina stove dissemination strategy in Peru, the Aprovecho report also noted, "The Peruvian stove dissemination strategy is one of the best I have seen. The strategy and cost for reaching the people with greatest need living in remote areas is excellent. It is encouraged that the designs and performance results of this project be shared with the greater stove community in the hope that a similar strategy can be followed in other areas worldwide."[5]

The Inkawasina stove incorporates clean and efficient combustion concepts, particularly "Rocket"[6] stove design principles, to increase energy efficiency while reducing emissions and indoor pollution. A chimney exhausts the remaining pollutants. The original Inkawasina stove used an all-metal chimney; however, the design was modified under this project to replace the metal with adobe for the indoor portion of the chimney to reduce costs. The stove is built on-site using locally available materials, including adobe bricks, locally fired ceramic "rocket" elbows, and cement (see **Figure 2**).

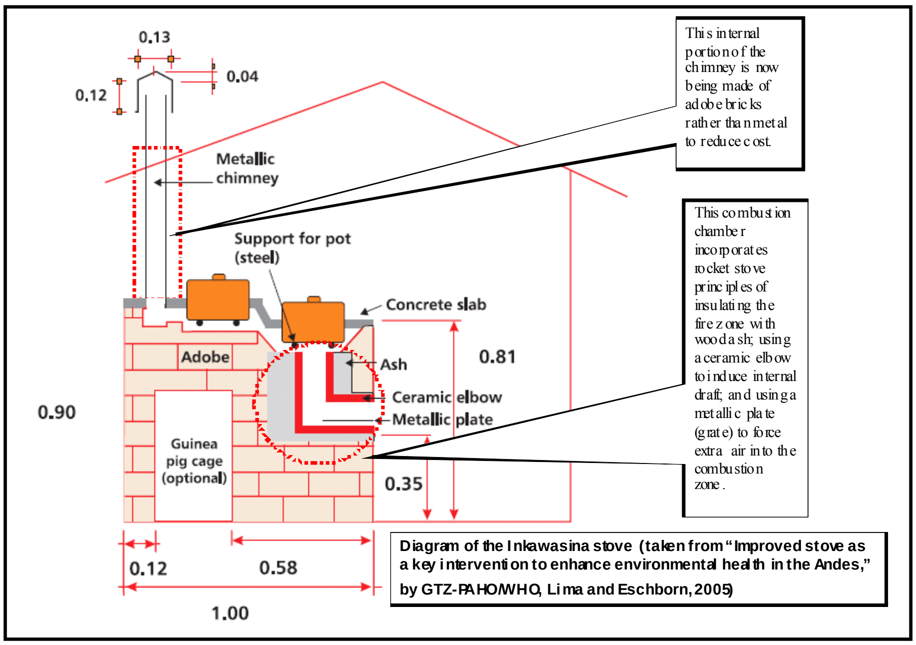

Figure 2. Detailed sketch of the Inkawasina stove

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[5] MacCarty, Nordica. Results of Testing and Existing Stove Design Recommendations: Peru. Aprovecho Research Center. October 2007.

[6] The "Rocket" stove was developed by Aprovecho Research Center. The principles of rocket stove design are incorporated into a wide range of stove designs in numerous countries. Key elements include: an insulated combustion chamber to increase the temperature within the fire zone; a grate to elevate the fuel magazine and allow adequate air (oxygen) to mix with the fuel gases; and an internal chimney that creates a natural draft within the combustion chamber, forcing the hot gases to rise and fresh air to enter the combustion chamber. These features result in a better mix of the fuel gases and oxygen and very high temperatures, such that the combustion is more efficient and generates fewer harmful pollutants. Additional design features, such as adding a "skirt" around the pot or sinking the pot closer to the flame, increase heat transfer efficiency, and thus facilitate a reduction in fuel use.

Winrock and Centro ECO designed a dissemination strategy that would make the Inkawasina stove affordable and accessible to interested families in the district and foster ongoing access in the future. Local artisans produce the "rocket" elbows, and the stoves are constructed by a select group of promoters in each EHC trained as stove builders under this project. Both the elbow makers and stove builders receive payment for their services from their respective EHAs.

To keep the stove cost low and to maximize the engagement or "buy-in" of the stove owner, the family must make the adobe bricks for the stove body, using locally available mud mixed with grass in wooden molds and dried outdoors. Each family must further contribute labor to assist the stove builder when he is constructing the stove in the family's kitchen. This contribution in adobe and labor by each family represents about 25% of the overall stove cost. The stove builders are responsible for buying or preparing other materials such as the cement plate to hold the pots, iron bars, rocket elbow and chimney cap.

The cost of the Inkawasina stove components are shown in **Table 1**, with the family contribution highlighted:

Table 1. Inkawasina wood stove cost breakdown

Component	**Cost:** ***soles***	**US$**	**Notes**
Masonry	27	7.54	Cost of mason's labor
Rocket elbow	17	4.75	Ceramic elbow
Metal parts	22	6.15	Iron bars, chimney hat and outdoor pipe, chimney paint, wires
Other parts	15	4.19	Cement plate, sand, wood mold for stove parts
Adobe bricks	33	9.22	Adobe, mud, wood ash (all provided by stove owner)
Assistant	5	1.39	Manual labor (provided by stove owner)
Total	**119**	**33.24**	

To supply the stoves with the ceramic "elbow" combustion chamber, several local promoters were trained as ceramic artisans. These artisans are now responsible for supplying all stove makers with this key component of the Inkawasina stove.

4. Developing a market: establishing entrepreneurs and micro-finance

At the heart of this project was Winrock's commitment to establishing a self-sustaining system through which residents of the Inkawasi district could obtain and maintain Inkawasi stoves beyond the life of this pilot. Thus the project also aimed to develop local entrepreneurs to provide the stoves, and a micro-loan system to accommodate local barter traditions while generating cash to pay the entrepreneurs.

Local capacity and entrepreneur development

Developing entrepreneurs required identifying dynamic and motivated leaders among the community promoters already trained in the benefits and basic functioning of the stoves. Centro ECO and the promoters agreed that the work of building stoves and constructing ceramic elbows would most appropriately be conducted by men. Though Winrock aimed to involve as many women as possible at all levels, Centro ECO was persuasive in arguing that both the physical demands and the time commitment away from home would render both jobs inappropriate for women, given local customs and gender roles.

The project aimed to train at least one promoter per community to build stoves, and at least two per EHA to make ceramic elbows. To enable local production of the elbows, the project planned to build one kiln per Association.[7] Centro ECO drew on its experience under the Ayamachay pilot to lead the stove-building training, and benefited from consultations with Winrock's Rogerio Miranda, an expert in rocket stove adaptations. Training on elbow production was led by the ceramist from the lowland city of Morrope (near Ferreñafe) who was responsible for making the elbows for the 60 Ayamachay stoves. After initially producing the elbows in parts on a potter's wheel and fusing the pieces, the ceramist developed a mold for faster production.

Facilitating access through micro-credit

The Inkawasi district is relatively isolated from the main cities of Lambayeque province. Located high in the mountains at the end of a winding, narrow, and bumpy uphill dirt road, the local indigenous communities have little mobility and face difficulties in trading with the more prosperous areas of Peru. Their traditional economy thus remains impoverished, based largely on subsistence agriculture and on bartering products among themselves, with relatively little cash exchange.

Centro ECO and Winrock designed a micro-loan mechanism that reflects this economic context, providing capital to enable borrowers to acquire the new and improved woodstove. The micro-loan system is based on animal husbandry: the borrower receives a "module" of several animals that reproduce to generate new "capital" or income with which to purchase the stove and repay the loan.

Loan conditions

To participate in this innovative micro-loan system, families needed to meet the following conditions:

1. Express interest in buying an Inkawasina stove to minimize household exposure to IAP.
2. Commit to the terms of the animal loan. Each family received an animal module (usually one male and five female chickens, or one male and ten female guinea pigs). The family had to return around 2.4 times the number of animals it borrowed. This "capital" covered the cost of the stove, repaid the loan principal, and generated an additional 40% for interest and a service fee.[8] Each animal module was valued at about 75% of the price of an Inkawasina stove (US$25)[9],

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[7] As noted in the Project Results section, a third EHA was created, leading to a total of six elbow makers and three kilns constructed.

[8] This service fee income was used by the EHA to pay the per diem of the technical promoters to assist neighboring villages and also for the EHA leaders to travel to Ferreñafe and Chiclayo to negotiate the sale of animals reproduced.

[9] The micro-loan financed 75% of the stove cost; the remaining 25% was provided through in-kind contributions from each family.

and the total repayment was equivalent to US$60 (the value of 2.4 animal modules). The repayment period was 12-18 months, with some flexibility to account for variation in animal reproduction rates. Once the first module equivalent was paid (U$25), the family was authorized to receive the installation of the stove, and then continued to pay back the remaining loan amount to the EHC.

3. Contribute in-kind by: a) making adobe bricks for the stove; b) providing additional labor to help the stove maker; c) building a secure animal pen with adequate water and appropriate shelter from the elements; and d) committing to care for the animals, providing food and paying for veterinary treatment as necessary.

Loan management

Families could choose between ducks, chickens, and guinea pigs for their loan. The EHC promoters monitored the animals' development and health, and tracked repayments.

Promoters were trained by Centro ECO to provide assistance to each family in the proper care of their animals. For a small fee, the promoters also administered basic veterinary services such as vaccinations and other treatments as needed.

5 Verifying changes in IAP and other indicators

To determine and demonstrate the effectiveness of the comprehensive Healthy Kitchen/Healthy Stove intervention, Winrock and its partners undertook monitoring of local practices and perceptions, indoor air quality, fuelwood consumption, and health symptoms using pre- and post-intervention surveys, focus groups, fuelwood monitoring, air sampling of PM_4 and CO, and spirometry to detect changes in lung function. Given the overarching goal of the project to reduce indoor air pollution, Winrock gave priority to monitoring PM_4 and CO to gauge project impact, followed by energy consumption. However, Winrock and Centro ECO also sought to track other impacts, such as time savings, to provide further insight into the project's success in bringing about effective and enduring changes in the cooking practices of Inkawasi families.

Pre- and post-intervention monitoring took place as follows:

- *IAP concentrations:* 24-hour measurement of PM_4 and CO concentrations in the kitchens of a >5% sample of intervention households (42 pre-intervention and 32 post-intervention), prior to the first stove installations, and again 12 and 24 months later. This work was conducted by Lima-based Swisscontact.
- *Practices and behaviors:* Surveying of >5% of the district's households (169 households), before intervention and 12 months later. This survey gathered information on awareness about IAP health risks and alternative cooking technologies; cooking practices, including type of stoves and fuel used, number of meals cooked per day; perceptions of how wood smoke affects the family's health; the amount, time, and costs associated with fuelwood collection; and other key information. The survey was developed by Winrock and implemented by Centro ECO with the help of several EHC promoters, who provided translation into Quechua.

- *Fuelwood consumption:* Measurement of household fuelwood consumption patterns (kg/week), conducted in >5% of the intervention households by Centro ECO engineer José Humberto Bernilla, with assistance from EHC promoters, in parallel with the household pre- and post-intervention surveys.
- *Health symptom impacts:* Spirometry (lung capacity) tests coupled with a survey on health symptoms in >5% of the intervention households, conducted by Dr. Jay C. Smith from Dartmouth University, before and after stove installation.

In addition to these measurement and survey tools, feedback from focus groups and trained promoters within the three clusters of Environmental Health Association villages provided additional insights on what has or has not worked, and why.

Local training was included for each monitoring component. For IAP monitoring, Swisscontact trained a field technician from Uyurpampa. For the surveys, Winrock and Centro ECO agreed that both men and women should serve as surveyors; Centro ECO conducted the training on the survey and data gathering procedures. Dr. Smith identified a local female nurse, bilingual in Spanish and Quechua, to facilitate the health symptoms survey, and a male assistant to administer the spirometry tests.

D. Project Team

Winrock International was the lead implementing organization for the project, guiding the design of the project and activity implementation, and providing technical assistance. Two local partners supported Winrock's work. The Centro de Ecología y Género (Centro ECO) was the lead field implementer for this project and supported all local implementation and much of the project monitoring and coordination. Swisscontact led the IAP monitoring component of the project. Dr. Jay Smith undertook health symptom testing and surveying before and after the stove installations. The full team is listed here:

Lisa Büttner, Winrock International
Rogerio Miranda, Winrock International
Dante Díaz, Centro ECO
José Humberto Bernilla, Centro ECO
Axel Krause, Centro ECO
José Reto Timaña, Centro ECO
María Vázquez, Centro ECO
Aida Figari, Swisscontact
Adrián Montalvo, Swisscontact
Dr. Jay C. Smith, Health symptom monitoring volunteer
Nelly Huaman, Nurse and translator
Luis Ferronay, Veteranarian
Victor Eduardo Bautista Carrasco, Graphic artist

II. PROJECT RESULTS

A. Summary

This pilot project reached a significant portion of its goals and surpassed several targets, as summarized in Table 2. Additionally, the project was able to gather data over two years, including pre-intervention, post-intervention, and one year after the end of implementation, which was both extremely helpful in project evaluation, and highly unusual for projects of this sort. The project achieved its primary objective of significantly reducing IAP among target households of the Inkawasi district. While the total number of installed stoves fell short of the target (largely due to slower than expected rates of animal breeding and loan repayment), as of August 2007 60% of the target number had been installed, with indications that dissemination would continue sustainably. Twelve-month post-intervention monitoring demonstrated the potential of this intervention for reducing indoor pollutant concentrations–there was an average IAP reduction of 84% in households where any reduction was noted (a majority of households monitored). A subsequent monitoring survey in July 2007 revealed lower reductions in 50% of the households, while the other 50% experienced no change or increases. This slippage was due to a combination of stove elbow failures, ill-fitting pots, and a tendency of some cooks to leave coals smoldering throughout the day. Both Winrock and Centro ECO believe they can remedy these problems with further follow-up to ensure the sustainability of the earlier–and significant–reductions in indoor smoke.

A project beneficiary with her Inkawasina stove. *Photo credit: Centro Eco*

Meanwhile, survey results showed that the vast majority of participating families were satisfied with their improved stoves. Many families invested their own time and materials to construct new kitchen rooms to accommodate the new stove, and have undertaken additional kitchen improvements to yield a more orderly and healthy environment. Fuelwood monitoring showed a reduction of 32% in fuelwood consumption, while many families perceived an even greater reduction.

During implementation, the project team and USAID recognized that the number of installed stoves was not the most telling indicator of long-term success. Indicators of the likelihood that local capacity, community organization, and financial mechanisms would endure over time were ultimately given greater weight. In this regard, the project has demonstrated success. By the end of the project, 527, or 88% of the target number of households, had acquired or committed to acquiring an Inkawasina stove (93% utilizing the micro-loan mechanism and 7% paying for the stove in cash); 68% of the original value of loans made had been recovered; and project surveys, focus groups, and anecdotal feedback indicated that a large majority of households in the district now understand the risks associated with IAP and are aware of measuresthey can take to reduce these risks.

The direct purchase by 36 families of Inkawasina stoves was surprising. This suggests that the IAP messages and appreciation for the advantages of the Inkawasina stove are spreading beyond the target population to an unexpected segment that both values the benefits and has the capacity to pay for the improved stoves without the assistance of a loan.

Since the close of the project implementation period in September 2007, the activities initiated in Inkawasi have continued and even picked up speed, with both increased stove demand, and increased promoter and manufacturer capacity to meet the demand. By September 2007 about 380 improved stoves had been purchased and installed and more than 400 animal modules had been distributed on loan. Since then project activities have continued without external funding. By March 2008 the Environmental Health Associations had supported the adoption of about 700 improved stoves, and loans of more than 800 animal modules. This continued success demonstrates the sustainability of the project, which relied on local organizations, developers, and community leaders influencing their neighbors and friends about the importance and benefits of the improved stoves.

Table 2. Quantifiable results of Healthy Kitchen/Healthy Stove project

INDICATORS (Household = hh)	**Totals (as of August 20th 2007)**
IAP reduction 2006: average for 42 hh	70%
IAP reduction for 30 hh w/ decrease	84%
IAP reduction 2007: average for 32 hh	-10% (increase)
IAP reduction for 16 hh w/ decrease	64%
Inkawasina stoves installed	377
Animal modules loaned	491
Value of animal modules loaned (*Soles*/US$)	S./40,262 (US$ 12,388)
Value of animal modules recovered (*Soles*/US$)	S./26,881 (US$ 8,271)
Direct sale of stoves	36
Environmental Health Associations formed	33
Cadre of community promoters trained in IAP, stoves	60
Stove makers trained (men)	21
Ceramic artisans trained (men)	6
Women trained on use & construction of retained heat cookers	35+
Murals installed	33
Posters distributed	600
Radio spots broadcasted	290
Flyers circulated	2,100

INDICATORS (Household = hh)	**Totals (as of August 20th 2007)**
Pictorial materials developed for household awareness and end-user training (# people)	1,000+
Healthy Kitchen competitions held	22
Professional meetings where project results were presented	8
Houses surveyed for practices/perceptions (pre & post)	169
Houses monitored for IAP	42
Average % of fuelwood reduction	32

B. Detailed Results

Based on these results and the lessons learned from this project, Winrock expects that the IAP reduction model developed in Inkawasi can be scaled up and replicated elsewhere in the region. This section provides a more detailed discussion of the results obtained through each of the project components.

1. Community organizations established

Promoters created and empowered

Centro ECO approached one community at a time to familiarize local leaders with the Healthy Kitchen/Healthy Stove project and seek interested and dynamic individuals to assume the role of community promoters. This process started in April 2005 and continued for several months as ECO reached out to a total of 33 communities. During initial project planning, Winrock had discussed a goal of working in 23 of the 60 communities in the district. Reaching approximately one-third of the district's communities would provide good coverage, without being too heavy a logistical and administrative burden on Centro ECO. As planning progressed, however, ECO proposed including 25 communities; in the end, ECO included even more communities in response to growing interest throughout the district. Thus, 33 promoters were identified and trained, one for each of the participating villages.

Promoters receiving training about IAP messages at Centro ECO's headquarters. *Photo credit: Centro Eco*

As of June 2007, ECO's 20 training sessions for promoters had attracted about 533 attendees.[10] The sessions covered the basics of IAP and associated health risks and how to avoid the risks by using

[10] Number of registered participants in all sessions organized by ECO. Many promoters attended more than one session.

improved wood stoves, improving ventilation, and adopting new habits to minimize IAP exposure. In addition, these promoters received training in five sessions (with about 70 attendances) on proper use and maintenance of the improved stove, as well as training in animal care and veterinary practices (nine sessions with about 179 attendances).

These volunteers were extremely effective as the primary promoters of the project in Inkawasi. They dedicated 10-15 hours a week to this work, receiving compensation in the form of new skills received through the training sessions, material goods (a hat, a bag, and promotional materials), and the pride and status of being recognized as an important member of their community. Promoters who provided veterinary care for the families also received a small fee for services performed (e.g., vaccination or medicine administered). As can be expected in any development project, some promoters dropped out of the project, often due largely to other time pressures. As of August 2007, 52 of the 60 trained promoters and stove builders were still active in Inkawasi.

In the identification of promoter candidates, Winrock and ECO discussed including both men and women as community promoters, including the possibility of pairs of promoters (one man, one woman) to maximize the effectiveness of message transmission, as well as the comfort level of women receiving visits in their own households. Both Winrock and ECO assumed that women promoters might be most effective at communicating health risks and cooking benefits to other women. Nevertheless, involving women as promoters turned out to be more difficult than anticipated. Of the 33 project promoters, about one-third were women. One reason for the lower than desired number of women participants was the significant time that promoters must spend away from home.

Training sessions on retained heat cooker (or "haybox") construction at Uyurpampa. Easily available cardboard was used to frame the haybox, which was insulated with locally available materials such as rice husks or wool and covered with plastic to protect against humidity. The haybox cover was a small pillow of cloth and insulating material. At the end of each training, the hayboxes built during that session were raffled off to participants. Recipients liked the hayboxes but found the Inkawasina stoves more exciting. *Photo credits: Winrock International*

On the other hand, women were successfully targeted and trained in how to build and use retained heat cookers, or hayboxes, which ECO introduced and tested with a handful of interested women after the majority of stoves were installed. As of June 2007, more than 35 women had been trained in the construction and use of retained heat cookers.

Institutions established

To provide logistical and long-term support to the project, including post-project support, Centro ECO built local institutional capacity to manage the project by helping the local communities form their own Environmental Health Committees (EHCs). In turn, Centro ECO organized the committees into associations to consolidate the management of funds, planning, and reporting by geographic region. Thus, the first two Environmental Health Associations (EHAs) were established with headquarters in Uyurpampa (on the west side of the watershed) and Incahuasi (on the east side). As the project developed, a third association was established in Rio Pampa to encompass communities at lower elevations in the southern part of the district.

The village-level committees assumed responsibility for promoting the project messages and components within each community. The most competent and available promoters were given the title of Technical Promoters and assigned by the EHAs to visit neighboring communities to supervise and assist local EHCs with priority tasks, for which they received a modest per diem from the association as an incentive (S/.6 per day). The funds used to pay the Technical Promoters came out of the 40% "interest" that families paid on their loans.

At the onset, the project aimed to establish 23 EHCs; however, as the project progressed and the publicity reached more villages, leaders from several additional communities approached Centro ECO asking to be included in the project. In the end, Committees were formed in 33 communities. In an example of the strength of the EHAs' capacity, eight of the last 33 Committees formed were created by the leaders of the three Associations, following the same methodology used by ECO to evaluate community interest and potential.

A planning meeting between Centro ECO and the EHA of Uyurpampa.
Photo credit: Centro Eco

Centro ECO's previous successful experience with developing community organizations and promoters in the low-lying community of Jayanca greatly contributed to motivating the promoters of Inkawasi. ECO has worked for eight years in Jayanca to form local committees and associations, train promoters, and create a conservation and environmental health development agenda in that community. To maximize the sharing of experiences, ECO on several occasions brought lead promoters from Jayanca to Inkawasi to share their knowledge and provide training to promoters from Inkawasi. In turn, ECO also brought key promoters from Inkawasi to Jayanca to learn first-hand about the environmental committees and animal micro-loans in operation in that community.

Centro ECO's high level of organization in planning, accounting mechanisms, and reporting schedules also contributed significantly to building solid community-based management through the EHCs and EHAs. Communications and project tracking benefited from monthly meetings between ECO and the EHAs, along with visits with specific EHCs to review and discuss:

- Progress reports by the EHCs to the EHA[11] and ECO on: new families wishing to join the project; new animal loans made; stoves installed and new stoves requested; animals recovered; and any other information relevant to that EHC.
- Funds requested by the EHA from ECO to cover new animal modules to be loaned, stoves to be installed, and promoter per diems. ECO kept control of the revolving fund until late 2006, when this responsibility was transferred to the Associations.

In total, ECO conducted 46 planning and review meetings with the EHAs and EHCs, which had 1,175 registered attendances.

Centro ECO also held meetings with local and municipal government representatives to secure cooperation and support for the project, and keep them posted on project progress, planning, and results. Meetings with regional leaders resulted in project results being incorporated into the Regional Environmental Commission's action plan. Centro ECO also met with Peru's First Lady, Mrs. Pilar Nores de García, providing an update on project methodologies and experiences, as well as the materials and tools to scale up the project to a national level.

Local management strengthened

Centro ECO began transferring responsibility for promoting project goals and administering the micro-loan funds to the EHAs in early 2007. Between January and June 2007, Centro ECO reduced field visits and staff time dedicated to project administration. During this phase, EHA leaders traveled to Chiclayo on a monthly basis to meet with ECO to report on progress and receive guidance as necessary. The EHA leaders volunteered their time for this effort; travel costs were covered by the interest on the micro-loan fund, for which they assumed full responsibility.

To reinforce the EHAs' capacity to assume full responsibility for fund management and project replication, Winrock provided a modest extension to the sub-agreement with Centro ECO to provide additional training to the EHAs. The training responded to needs identified by ECO through feedback and by Winrock during focus group discussions held in late 2006 at the EHA headquarters. In addition to improved financial and animal management, ECO expected the follow-up training to help mitigate the loss of promoters who chose to leave the project. While drop-outs were not a major problem (52 of 60 trained promoters and stove builders are still active) and the motivation and dedication of the promoters remains high, personal circumstances have led some promoters to leave the project to concentrate on their crops, studies, or other family or work matters. As the EHA recruits replacements, more in-depth training may provide the needed incentive to attract good candidates.

[11] On average, each member of the EHA dedicates three to five hours per week for meetings with EHCs and a monthly meeting with ECO.

Financial management training

This training focused on basic accounting to strengthen the leaders' understanding of the importance of cash flow planning, shorter loan recovery periods (and associated animal management issues), and charging and scaling interest as a function of time to discourage drawn-out repayment periods. Focus group discussions revealed that although the leaders of the EHA were motivated and engaged in the project, they lacked a degree of entrepreneurial vision. The additional training for the EHA leaders aimed to instill this business sense and strengthen the promoters' skills in managing loan funds so they would grow, and not dissipate, over time. With Winrock's assistance, ECO designed a simple financial plan to ensure a sustainable cash flow into the future. The plan included monthly estimates of animal modules to be loaned and recovered, as well as the number of stoves to be built, so that the EHAs can balance their finances and have capital available for new participants. This plan was shared with the EHAs as part of the training.

Veterinary training

ECO provided promoters with training in basic veterinary care, so that the promoters could better assist families in properly caring for their animals and, consequently, repay their loan as quickly as possible. A core objective of this training was for the EHAs and EHCs to develop a clear understanding that the health of the animals was directly related to their working capital, and that the animals must be well-tended in order for the EHAs to be able to maintain an ongoing financial capacity to promote stoves and pay the technical promoters and stove builders for their services.

2 Awareness raised and behaviors changed

Evidence from field trips, household surveys, and focus groups – and the ongoing demand for the Inkawasina stove – suggest that families throughout the district have become much more aware of the health risks of IAP and steps they could take to mitigate the risks. During the focus groups, which consisted of members of households in which stoves were installed, women stressed that they were happy with their new stoves and didn't want to use open fires indoors anymore; rather, they would reserve cooking over open fires for special occasions when they needed to cook for larger groups, and they would do so outdoors. The post-intervention practices and perceptions survey showed a similar increase in awareness in the general population: in response to a question about how to avoid indoor smoke, around 51% of the interviewees suggested acquiring an

"My new baby does not tolerate being around a smoky kitchen, as she was born after my new Inkawasina stove was installed. She cries out loudly when there is smoke in the kitchen," says Silvia Aurora Carlos de la Cruz, beneficiary of the Healthy Kitchen project in Uyurpampa.
Photo credit: Winrock International

improved stove, 32% recommended improving ventilation, and 15% recommended having a kitchen that is separate from the rest of the house. These responses showed marked increases over the respective 18%, 15%, and 8% of interviewees who suggested these measures during the baseline survey.

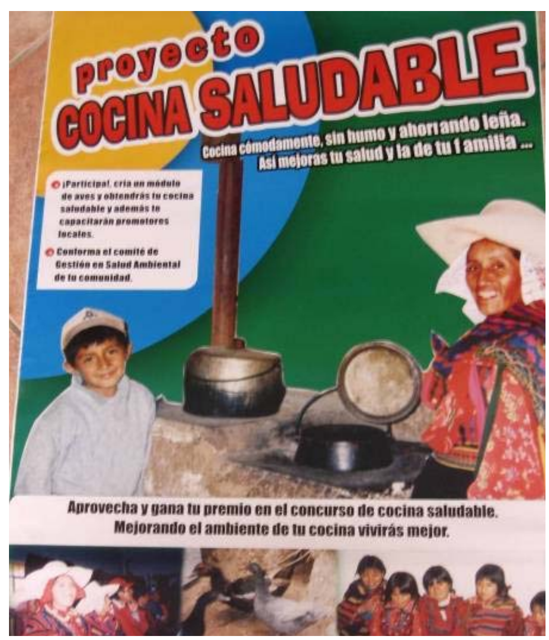
The overall social marketing approach thus appears to have been fairly effective. It began with local workshops among community leaders (Uyurpampa and Incahuasi) and at the municipal level (in the capital, Ferreñafe), followed by a mixed-media campaign using radio announcements, posters, and word-of-mouth through trained promoters. The social marketing approach ended with the "Healthy Kitchen" competitions to stimulate additional awareness and motivation among families with stoves and their neighbors.

As anticipated, based on Centro ECO's experiences with similar beneficiary groups elsewhere, initial engagement was slow due to the uncertainty of beneficiaries about project intentions. As the project rolled out, however, people became more confident, began participating in activities, and enlisted in the project. Similarly, the process of training promoters was ongoing as ECO approached communities and identified promoter candidates. Based on post-intervention survey results, the most effective means of raising awareness appears to have been the household and village-level visits of the promoters. Centro Eco's emphasis on personal contact with the target groups helped bring about widespread interest in the new stoves.

The initial murals were painted on walls throughout the first communities.

Mixed media in public spaces

Centro ECO designed and produced 300 posters announcing the project. With the help of promoters, these posters were distributed widely throughout the district, along with large murals posted in central locations in each of the 33 EHC communities.



The first poster (shown at bottom right) announced the project to the Inkawasi district: *"Healthy Kitchen/Stove Project. Cook comfortably, without smoke and with less wood. Improve your health and that of your family."* The language continues: *"Seize the opportunity to win your prize in the healthy kitchen competition. Improve your kitchen environment and live better. Get informed by the Environmental Health Committee of Uyurpapma or Inkawasi."*

Photo credits: Winrock International

Radio spots

Centro ECO developed four radio spots using both Spanish and Quechua in the same spot, and each was broadcast for one month. The first message, delivered by ECO, announced the project and invited participation (see dialogue box on next page). The subsequent three spots were formatted as a dialogue between Inkawasi residents.[12] The 30-second radio spots were broadcast on the local station Radio JHC between 6:00 and 7:00 pm, repeated three times during the hour, every day for three months. Information on the best time of day and preferred radio station for broadcasting to Inkawasi families was identified through the baseline survey. This was the hour during which husbands and wives would typically be home together listening to the radio. It is also common for men throughout the district to walk with their radios hanging around their necks.

Healthy Kitchen Radio Spots

Dialogue 1
Voices: Two women—a Healthy Kitchen promoter visiting the house of her friend Virginia
Synopsis: While visiting, the promoter observes that Virginia's children are coughing near the open fire. She explains to Virginia that wood smoke causes respiratory illness, eye irritation, and shortness of breath, potentially leading to death, and that a new project in Inkawasi is facilitating new improved woodstoves that are much cleaner and more efficient for cooking. She invites Virginia to join the project and offers to facilitate her contact with the EHC.

Dialogue 2
Voices: Virginia and her husband
Synopsis: After joining the project, Virginia and her husband attend a meeting of the EHC. Virginia mentions that she has raised guinea pigs to buy the improved woodstove. Now that she has the stove, she says her kitchen is much cleaner without smoke, and her family's health is much better as they no longer suffer from respiratory or eye illnesses. The couple mentions to the group that the new stove also uses less fuelwood, and that raising animals doesn't take much time, so the improved stove can be obtained rather quickly. They invite the listeners to join the project and to seek their nearest EHC to obtain more information on how participate.

Dialogue 3
Voices: Male promoter and Mrs. Silvia, a project beneficiary
Synopsis: Before asking Mrs. Silvia how she likes her new stove and how easy it is to use and maintain, the promoter points out that her kitchen is clean and smoke-free, with good ventilation due to an open window. He also mentions that 150 other families in Inkawasi have improved stoves. Mrs. Silvia responds that before she had the Inkawasina stove, she could not even see her pots due to the thick smoke, that her eyes always watered a lot, and now her stove saves energy by using smaller pieces of wood and cooking faster. Mrs. Silvia also points out that the stove is easy to clean, as she learned from the promoters. Finally, the interviewer invites the listeners to hurry and join the project, and to visit their neighbors who already have new stoves to see for themselves how happy they are with the Inkawasina stove.

[12] The dialogue format was proposed based on the effectiveness of social marketing materials developed for USAID's Kenya Indoor Air Pollution Reduction Initiative (KIAPRI) project: Helping Women Entrepreneurs Commercialise Low-Cost Cooking Products in Peri-Urban Settlements.

The radio messages spread initial information about the project quickly. The spots appeared to have been particularly useful in prompting several leaders of communities reached by the radio messages to approach the EHAs and ask to join the project and form EHCs. However, the post-intervention survey conducted by Centro ECO suggested that the radio spots were less influential than direct visits by promoters in raising awareness among typical households about the project and its messages, perhaps due to their limited broadcast time. Future radio campaigns should be run for at least six months, and in the local language (Quechua, in this case) for maximum impact.

Household and village-level visits by promoters with illustrated materials

In the post-installation survey, 54% of the interviewees reported that the family visits, women's gatherings, and village-wide visits by the promoters were the most effective promotion techniques.

A promoter points to illustrations on the kitchen wall of a beneficiary household depicting proper stove operation and maintenance.
Photo credit: Winrock International

Centro ECO developed a set of educational materials depicting core messages about the health effects of IAP, the benefits and use of improved stoves, fuel preparation and maintenance, and related topics. Centro ECO engaged a local artist and communications expert and used an interactive process to develop the materials based on feedback from focus groups and input from Winrock. Each promoter received his/her own set of materials to use with the families. The materials depicted health effects that included coughing, runny noses, shortness of breath, and death of young children. Pictures featured the Inkawasina stove in a clean kitchen; proper operation of the stove, including covering the pots and cook holes; splitting and drying the fuelwood and lighting the stove; as well as stove maintenance, with particular emphasis on removing the ash and cleaning the chimney. Other pictures suggested opening windows for better lighting and ventilation, and finishing walls and using shelves for a cleaner and more orderly kitchen. With no text, the pictures were particularly effective for educating illiterate community members.

In addition to using the materials to raise general awareness throughout the community, promoters used them to train users when their stoves were completed and lit for the first time. Beneficiary families received small versions of the illustrated messages to hang on their kitchen walls. The complete set of illustrations is included in **Annex II**.

Healthy Kitchen competitions

The Healthy Kitchen competitions proved to be extremely useful in getting the attention of the communities. A total of 22 competitions were held within the district to raise the visibility of the Inkawasina stove and complementary kitchen improvements undertaken voluntarily by families. The competitions were designed to spotlight role models within the communities and infuse a sense of ownership and pride in having an improved stove and creating a healthy kitchen space.

This family won one of the competitions for a healthy kitchen, by making a new window, drying firewood, and building a shelf for orderly storage of kitchen items, in addition to using the Inkawasina stove properly.
Photo credit: Winrock International

Competitions were held in communities with a minimum of five families with Inkawasina stoves; the corresponding promoters identified the families interested in participating. A committee of judges (lead promoters) was formed within each EHA; this committee was responsible for visiting at least 15 participating families across two to three communities. During these visits the judges observed overall kitchen organization and cleanliness; whether the Inkawasina stove was operating properly,[13] and the level of lighting and ventilation. The judges awarded kitchen utensils such as new pots, pans, and silverware to the five best kitchens in the competition area.

Engineer Jose Humberto Bernilla (right) and a ceramic artisan trained to produce rocket elbows in Uyurpampa stand in front of a newly built ceramic kiln. *Photo credit: Winrock International*

3. *Market system developed for sustainability*

Local entrepreneurs trained to supply the stoves

A core factor in developing a local market for the Inkawasina stove was the identification and development of local entrepreneurs. This capacity was divided into two basic roles due to the requirement of distinct skills: ceramic combustion chamber (elbow) making and in-situ stove building. Six ceramic artisans were trained to make the rocket elbow combustion chambers, and 25 people were trained to make stoves, of which 21 remain committed to providing their commercial services to the 33

[13] Although the stove did not necessarily have to be lit at the time of the visit, the judges looked for evidence of its proper use.

communities. Both the elbow makers and the stove builders are paid a fee for their services, and this fee is included in the cost of the stove. Most of these men are farmers earning very little from their primary occupation, and so their stove-building activities provide a much-needed second income.

Posters with the names and photos of the stove makers trained by ECO were disseminated throughout Inkawasi.

Photo credit: Winrock International

Stove construction

Centro ECO closely supervised the first stoves made by each stove maker and facilitated corrections as necessary to ensure adherence to a standard design. ECO was very strict with the stove design and cautioned against any modifications that might inadvertently reduce the stove's efficiency. Experience around the world has shown that over time, as stove makers gain confidence in their skills, they often introduce what they believe to be "improvements" to the design that in fact result in worse performance.

To raise the visibility of the stove makers, Centro ECO prepared a poster with photos of the entrepreneurs and their names. These 300 posters were distributed for display around the district, so that people would recognize the stove makers and consult them about the stoves. In addition, a sign was hung outside each stove maker's house to advertise his services.

Micro-loan system established

Centro ECO's micro-loan scheme was based loosely on Heifer International's "Passing on the Gift" model of animal husbandry. Winrock provided ECO with seed capital to provide 600 micro-loans, reflecting the project's target of introducing improved stoves to 600 families. Each loan was in the form of a "module" of animals, which was equivalent to 75% of the total value of an Inkawasina stove or S./82 (US$ 25). By August 2007, 491 loans had been made, for a total value of S./40,262 (US$ 12,388), of which 68% had been recovered. The loan portfolio was 45% guinea pigs, 39% chickens, and 16% ducks.

Ducks, chickens, or guinea pigs for stoves?

At the onset of the project, Centro ECO recommended using ducks for the animal modules, due to its successful earlier experience reproducing ducks in lowland communities. However, the ducks reproduced much more slowly than expected in Inkawasi, apparently due to poor adjustment to the higher altitude. In addition, the lack of experience among families in raising ducks led to higher mortality rates than expected. Centro ECO was slow to respond to this problem, believing that better veterinarian training could address it. After nearly six months had passed with little improvement in reproduction rates, the Winrock team directed ECO to stop promoting ducks. Instead, ECO was encouraged to consider using animals better adapted to the Inkawasi area, such as chickens and guinea pigs. In November 2005, ECO ceased promotion of duck modules for the higher elevations and began promoting guinea pigs and chickens instead.

The original plan, designed jointly with ECO's veterinarian, called for families to reproduce and pay back to ECO[14] the complete animal module loan within nine months of receiving the initial set of animals. However, this payback period had to be extended to reflect the poor adaptation of the ducks and lower rates of reproduction among the chickens and guinea pigs, which initially suffered from inadequate animal care. Winrock observed that many animals were lost and reproduction delayed due to preventable diseases, predation by other animals, and exposure to cold and malnutrition, all of which should have been avoidable. The families themselves acknowledged their problems during the focus group discussions. However, in some cases families purchased animals to replace those that were lost, sometimes buying only females and borrowing successful males from the promoters, in order to breed stronger animals.

Unexpected Result: Direct Sales

The promoters of Rio Pampa EHA have been extremely effective in motivating families to tackle IAP and invest in a stove. Although Rio Pampa's EHCs are among the most recently created, this region has already surpassed Uyurpampa (among the first EHCs created) in number of stoves installed and also in the number of animals recovered. Moreover, to the surprise of Winrock and Centro ECO, roughly 20% of all families who have committed to having a stove have purchased the stove directly with cash. Despite the expectation that the families of Inkawasi are too poor to pay directly for the Inkawasina stove, a total of 36 families around the district did just that. Of these, 28 were sold in Rio Pampa. This suggests some unanticipated market segmentation within the district. It is possible that the residents of Rio Pampa are on the whole better off than villagers at higher altitudes, and perhaps less used to receiving international aid. The cash sales may also indicate a more effective awareness-raising campaign by Rio Pampa EHC or an overestimate of the need for micro-credit in this particular area.

An unintended consequence of the animal module delays was the delay in stove installation.[15] The project thus faced difficulty in gaining momentum early on, since the installation of Inkawasina stoves was key to stimulating interest and motivation among both the promoters and general public. To avoid more serious delays, in October 2005 Winrock and ECO agreed to modify the repayment plan and allow the first phase of stoves to be installed before families had fully repaid the first module.[16] The first stoves

[14] During the project implementation phase, ECO was responsible for administering the micro-loan fund (the equivalent of 600 animal modules). In the close-down phase of the project, ECO transferred this responsibility to the EHAs.

[15] In order to have the stove installed, each family should have first paid back a complete animal module, equivalent to the value of the stove.

[16] ECO's experience with the Inkawasi people instilled trust that they would ultimately honor their loan commitments.

were installed in the homes of the project promoters, who were the first families to participate in the project. ECO believed their experience would provide effective testimony on stove performance, and the associated reduction in both IAP and firewood consumption.

Project promoters check on the progress of animal reproduction with a beneficiary family.
Photo credit: Centro Eco

Repayment patterns

Of the total 491 modules loaned by August 2007, the EHAs had received repayment for the equivalent of 328 modules, or S./26,881, loaned as of August 2007. Rather than paying a full module at once, families paid back incrementally, with one or a few animals at a time, as they became available. As a result, the 328 module-equivalents repaid to date actually represent repayment by about 440 families (out of 491 borrowers) of less than a full module, while 51 families have repaid the full module, though with some delay.

In the absence of a penalty for late payments, promoters had to be patient, accommodating the needed time for animals to reproduce and families to pay back the animals. However, Winrock anticipates that eliminating the duck modules and providing better training to promoters in animal care will result in greater success with reproduction and thus fewer delays in repayment. A penalty or interest charged on late payments may further facilitate timely payments.

Conversion of animals to currency

The micro-loan system was designed to enable families with little or no cash to pay for their stoves, while generating a range of jobs with cash income. **Figure 3 on the next page** illustrates the flow of animals and cash in this micro-loan system.

The animal modules were thus planned to be utilized in the following ways:

- As part of a revolving loan fund, transferred to the next families/borrowers in line.
- Sold within local markets, including Inkawasi's limited cash market, or more active markets in Ferreñafe and Chiclayo (approximately 80-100 kilometers, a 3-4 hour drive away) to generate cash to cover the costs of the stove and pay promoters for promotion work and veterinary services.

One interesting development was a contract between Centro ECO and Marako's, one of Chiclayo's largest barbecue restaurants. The restaurant created a new barbecue dish using guinea pig meat, and it agreed to pay a premium price for the Inkawasi meat because it is being produced under a social development project. Marako's is paying S./13 per animal, over 40% above the market rate for guinea pig meat in Chiclayo (S./9 per animal). Marako's has been buying about 10 guinea pigs per week from the EHAs. This amounts to roughly 6 kg of meat per week or 24 kg per month, with a **total income value of US$160 per month**. To facilitate on-demand supply to

Marako's, Centro ECO set up a holding pen on a small farm near Chiclayo belonging to one of its members. The meat is also prepared for delivery at this location, according to orders from the restaurant.

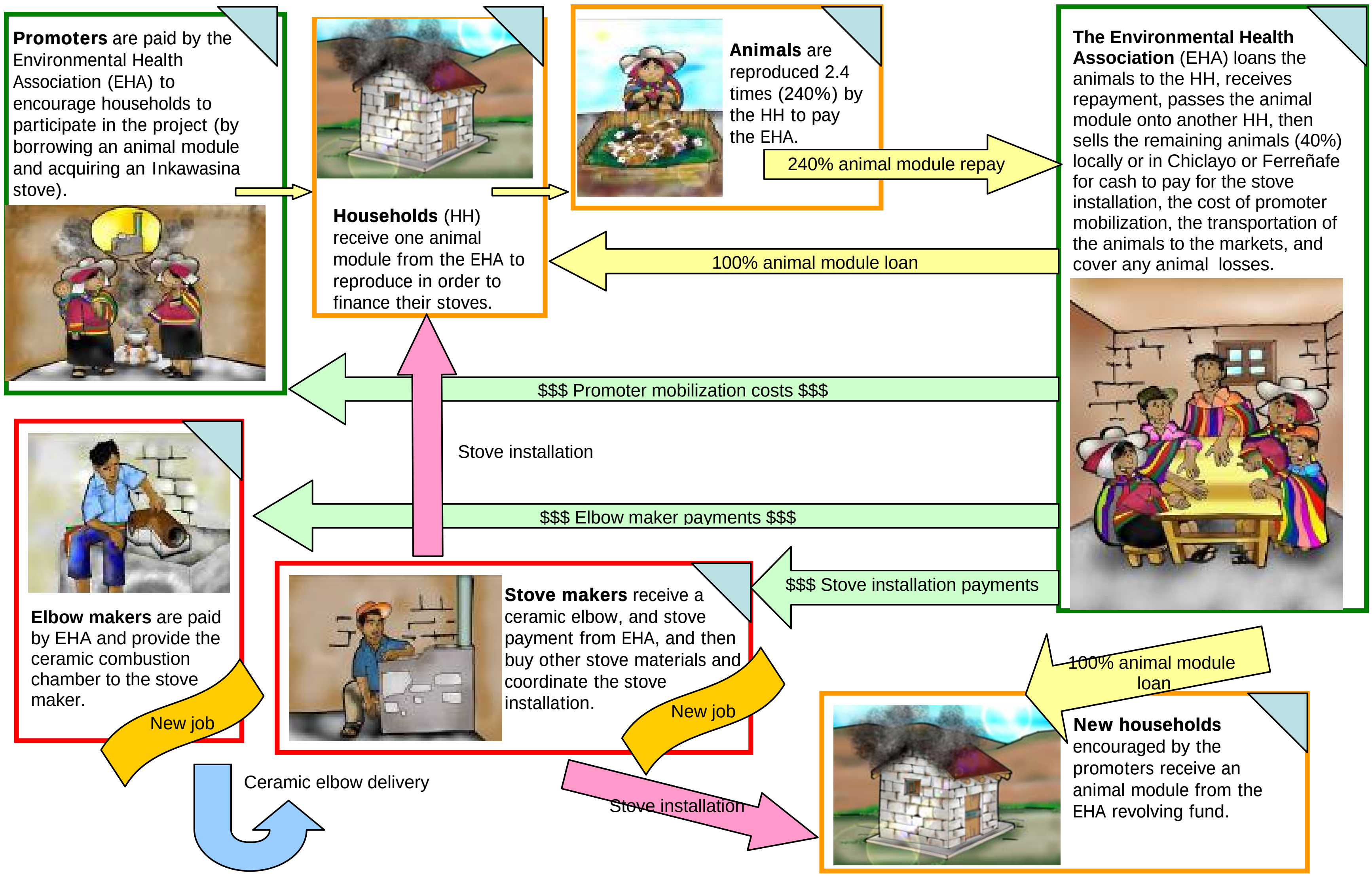


Figure 3. Animal module-based micro-loan scheme

4. Appropriate technology adopted

As of August 2007, Inkawasina stoves had been installed in 377 homes. Though this number falls short of the project's goal of 600 stoves, other indicators suggest that satisfaction with the installed stoves is high, and that despite early delays in animal reproduction (and thus stove installation), a solid momentum has been established and demand for stoves continues to be strong.

In 2007, ECO reported a few cases of cracking of the combustion chamber elbows, and eventual collapse in some cases. During field visits Winrock investigated the elbow failure issue and found this indeed to be a problem. Elbow collapse was also apparently a problem with households that participated in the original pilot in Ayamachay, and in general is a common weakness of stoves with low-cost ceramic combustion chambers around the world. To minimize failure, ceramic liners must be reinforced. Most importantly, however, users must be aware of the problem and be careful when feeding the fire. At project onset, Winrock made recommendations to Centro ECO to reduce cracking, including reinforcing the elbow by tying it with stainless steel wires, and making three artificial vertical crack lines to control the cracking. Although Centro ECO piloted these recommendations, some combustion chamber problems persisted.

Under the current project in Inkawasi, the EHAs claimed that the elbow failure problem was manifested in about 3% of the stoves installed. Some promoters blamed the breakage on user behavior, claiming that a minority of cooks continued the habit of feeding large trunks of wood, in some cases forcefully, into the combustion chamber, thereby fracturing the fragile ceramic. Other feedback claimed that the elbows that failed were all made at the same location, suggesting that there were problems with either the materials or the firing technique (or both). Some of the households whose elbows failed requested a replacement ceramic elbow (and were willing to pay for it), while others did not make such a request and unfortunately ceased to use the stove.[17]

Regardless of the specific shape or reinforcement, robust and crack-resistant elbows require a source of good clay and production techniques that include proper temperature firing and the addition of refractory materials to the mix. Furthermore, stove users' awareness of the fragility of the elbow and careful use also needs to be reinforced. Centro ECO is keenly aware of the impact that elbow problems could have on broader perception of the product within the district, and is eager to confirm the primary causes of the failures and both take corrective action to fix the damaged stoves and reinforce the training for both elbow makers and stove users to mitigate further occurrence of this problem. For example, the stove engineer began recommending to the ceramic artisans that they reinforce the elbow by thickening the areas most likely to crack, and exploring the idea of using a square combustion chamber made of six tiles, which would allow for easy replacement of the broken piece. Centro ECO did eventually switch to the square tile chambers, which has eliminated the cracking problems. Some of the broken elbows have since been successfully replaced with this alternate combustion chamber model.

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[17] The exact number of households that have abandoned their stoves is not known by ECO, but it is within the 3% estimated group of breakages.

Results from ECO's post-installation surveys and focus groups generally reflect happy customers who are pleased with the reduced indoor smoke and reduced time spent gathering wood, and who feel the loan system is an appropriate mechanism for paying for the stoves.

Installation dynamics

Stove distribution went relatively well. The process followed these basic steps:

- An EHC identified at least five families ready for stove installation. Readiness criteria included repayment of a full animal module and preparation of the adobe bricks. As discussed earlier, however, the module payback criterion had to be relaxed to speed up installation. As animal and financial management improve, the original payment scheme is expected to resume.
- The EHC requests the respective Association's authorization to install the stoves. After reviewing each case, the EHA authorizes the stove installation.
- The Association hires the nearest available stove builder(s) to install the stoves in the community in question.
- The stove builder visits the homes to discuss installation dates, stove location, and labor and materials needed from the family (adobe bricks, mud, and wood ash).
- The beneficiary families prepare their inputs, typically one to two weeks prior to the agreed date.
- The EHA provides the stove builder with the balance of materials (the ceramic elbow, the cement to make the cooking plates, iron bars, and the metal chimney top and cap).
- The EHA pays the ceramic artisan for the elbow and the stove builder for on-site construction.
- The homeowner provides labor to assist with construction.

ECO planned the majority of stove installations during the dry season (April through November), given the virtual impassability of the muddy mountain roads during the rainy months and the need for uninterrupted periods of sun to make the sun-dried adobe bricks. Thus, although stove installation began in October 2005, it quickly slowed down in December, resuming speed again in April 2006. During the rainy months, ECO conducted limited project activities in the lower-altitude communities that their vehicles could still reach. The broader project promotion activities continued during this time. Project community leaders (EHA representatives) traveled by foot and public transportation to meet monthly with the Centro ECO team at ECO's office in Chiclayo.

Stove performance: IAP reductions

Initial post-intervention monitoring revealed significant IAP reductions: 70% for respirable particulate matter, and 71% for carbon monoxide, on average, across 42 households. These results are discussed in greater depth in the next section. While these results are quite encouraging and come close to the project's goal of 80% reductions, the Winrock/ECO team believes, based on field observations and experience with other stove designs, that further reductions can be achieved with minor modifications to the

Inkawasina stove. The most obvious drawback of the Inkawasina model is the tendency of smoke to escape around the pots when set into the pot holes. This "pot hole" design was chosen for a few reasons, including cost first and foremost, and because heat transfer efficiency is greater when the pots are sunken and have greater contact with the flames and hot gases.

Stove builders build the pot holes in diameters that correspond to the cooks' most commonly used pots. However, because cooks in the region use up to five different diameters of pots and kettles, inevitably the two pot holes do not properly fit all pots used in that kitchen. Using a kettle without any adjustment to the pot hole results in significant smoke leakage. ECO's engineer Bernilla thus designed a metal plate fashioned out of large oil cans commonly found in the region, cutting a hole the size of the kettle (or smaller pot) to block the gap between it and the larger hole. The metal plate can also be used without a hole as a cover for the pot hole and to place the kettle or small pot on top of it (as shown at right). It is uncertain at this point how many of the households with kettles have been shown this technique, however, and how effective the metal plate is in reducing smoke leakage.

Inkawasina stove user, properly using the stove. Although the front pot hole is larger than the kettle, she is using a metal plate to cover the gap to prevent smoke leakage. *Photo credit: Winrock International*

Stove performance: efficiency

In response to Centro ECO's post-intervention survey, stove users have anecdotally reported about 60% savings in fuelwood. Though data suggests this figure may be inflated, two-thirds of users also report that the time needed for cooking each meal has been significantly reduced, from over two hours to between one to two hours, on average.[18]

To verify fuelwood savings, Centro ECO monitored fuelwood use among 42 households both before stove installation and after stoves had been installed for a minimum of 30 days (much longer, in many cases).

Centro ECO's engineer Bernilla coordinated the monitoring with the support of local promoters. Each household was monitored every day for a week. The fuelwood was weighed using a simple scale (the type commonly used in farmers' markets). The promoters separated enough fuelwood to be used for each family for more than one day; and on the following day they would measure the amount used the previous day, and then add and weigh a new amount to the pile for next day's consumption. Moisture content

[18] The perception of time savings is not based on real time measurements.

was not included in the calculation. However, the pre- and post-intervention monitoring sessions were conducted at roughly the same time of the year (around August) to avoid seasonal variation in ambient air humidity.

This monitoring showed a notable reduction in fuelwood consumption after the installation of a new stove. On average, these families consumed 66 kg/week using a traditional open fire, prior to the intervention. Their consumption dropped to an average of 45 kg/week using the Inkawasina stove, a savings of roughly 32%.[19] Since a secondary function of stoves in Inkawasi is space heating, there was some concern that the stove might not serve this purpose adequately. However, to date no beneficiary has complained that her kitchen is now too cold as a result of installing the Inkawasina stove.

Winrock and Centro ECO believe that greater energy efficiency can be achieved through additional technology and behavioral improvements. As these improvements are made, ECO will have the capacity to repeat the fuelwood monitoring to verify any efficiency increases.

Design improvement: comparison of stove variations

In order to explore other stove models that could further reduce IAP, Winrock helped Centro ECO build and test two other stove designs and compare them with both the Inkawasina model and an open fire in terms of efficiency, IAP levels, and user preference.

The two alternative models had the same insulated ceramic “elbow” combustion chamber as the Inkawasina stove, but modified heat transfer systems. In both cases, an iron plate replaced the concrete “pot hole” frame of the Inkawasina stove. The first alternative design had two pot holes with three graduated-diameter metal discs to accommodate pots of different sizes. This is similar to the heat transfer system of traditional wood stove designs in Europe and the United States. The second alternative design used a solid metal griddle cooking surface, similar to the Ecostove.[20] The griddle surface has the advantage of eliminating smoke leakage from the cooking surface and enabling the simultaneous use of multiple pots and/or direct grilling of tortillas or other foods.

This Inkawasi resident tested the Ecostove for five months in Uyurpampa.

Photo credit: Winrock International

[19] The thermal efficiency coefficient of about 27% obtained at this time by engineer Bernilla for the Inkawasina stove is comparable to the 28% obtained for the Inkawasina stove during the Ayamachay project phase under GTZ in 2003.

[20] The Ecostove is a popular stove being produced in Nicaragua, Honduras, and Brazil, and uses a rocket stove combustion chamber and a flat solid metal griddle for the cooking surface.

To compare the performance of the three stove models with each other and a traditional three-stone open fire, Centro ECO set up a testing room in Uyurpampa in which all four options were installed. This set-up enabled comparison of IAP concentrations in a controlled environment. ECO conducted an energy efficiency test for each stove, and Swisscontact measured the resulting IAP concentration levels. The results suggested that the griddle surface reduces CO emissions more dramatically than the Inkawasina, but is less energy-efficient and more expensive due to the use of elaborate metal work (griddles with soldered undersides). To date, however, only a single test has been performed for each stove, and thus the results are not conclusive. Further trials are needed to compare the relative performance of these models.

In addition to these "lab" comparisons, Winrock built a portable Ecostove for ECO to try out. The wife of one of the project promoters used the stove for about five months alongside the Inkawasina stove. She preferred the Ecostove because of its cleanliness, as it produced no smoke and left no soot on the pots. However, the particular benefits of this stove model need to be weighed against the higher cost of a solid metal griddle over the cement stovetop of the Inkawasina model.

5. IAP reductions achieved

Swisscontact conducted measurements of respirable particulate matter (PM_4) and carbon monoxide (CO) concentrations in August/September 2005, prior to the intervention, and again in October 2006, after the Inkawasina stoves were installed. A third round of monitoring was conducted in July/August 2007 to verify any changes from the post-intervention values obtained in 2006.

Of the original sample of 48 households, valid data for both pre- and post-intervention measurements was obtained for 42 households in 2006. Data was obtainable for 32 households in 2007; as the target sample size was 30 households (5% of the 600-household intervention goal, but almost 10% of the stoves actually installed), the initial sample size was sufficient to allow for dropout. (See **Annex III** for the IAP monitoring protocol and **Annex IV** for detailed results.)

Baseline conditions

The baseline measurements revealed extremely high indoor pollutant concentrations, with an average 24-hour concentration of 680 $\mu g/m^3$ for PM_4–exceeding Peru's Environmental Air Quality (EAQ) ambient standard for $PM_{2.5}$ by more than 10 times–and reaching a maximum of 3,880 $\mu g/m^3$. The median concentration for PM_4 was 322 $\mu g/m^3$. CO concentrations were similarly elevated, typically dropping below the average hourly standard only between 11 pm and 5 am.

Impacts achieved

The 2006 post-intervention results demonstrated that the intervention had reduced particulate matter by an average of 70% and CO by 71% across the 42 households. Surprisingly, 12–or almost 30%–of households experienced little change or an increase in contaminants. Possible contributing factors are discussed in the section on lessons learned. For the 30 households that demonstrated drops in PM and CO, the average reduction was 84%. This result confirms that the Healthy Kitchen/Healthy Stove intervention has the potential to significantly improve indoor air quality. Few improved stove interventions have shown reductions of 80% or more.

Clockwise from top left: Kitchen smoke levels before and after stove installation; filters from monitoring equipment before and after monitoring; monitoring equipment and staff.
Photo credits: Swisscontact

At the time of post-intervention monitoring in August 2006, some stoves had been installed for only a few weeks. Because optimal stove performance is user-dependent, reductions were expected to improve as cooks got better at managing the fuel and the fire. Winrock thus requested that Swisscontact conduct a final round of monitoring in July 2007 to confirm IAP reductions after a longer adjustment and learning period.

Figures 4 and **5 on the next page** show the extent of IAP reductions achieved as of September 2006.

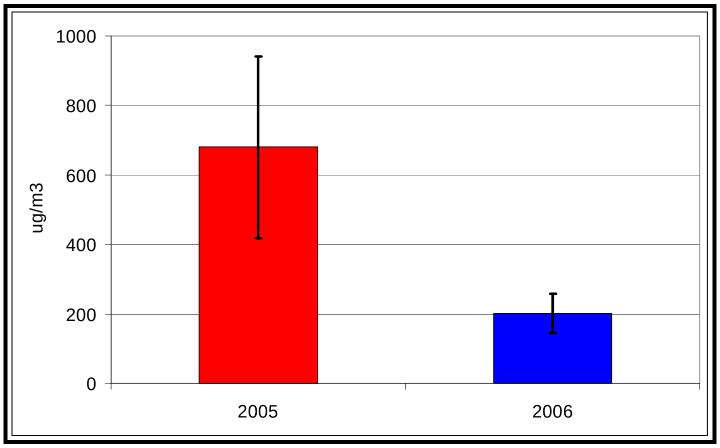

Figure 4. Average 24-hour PM_4 concentration and confidence intervals before (2005) and after (2006) installing improved stoves (n=42)

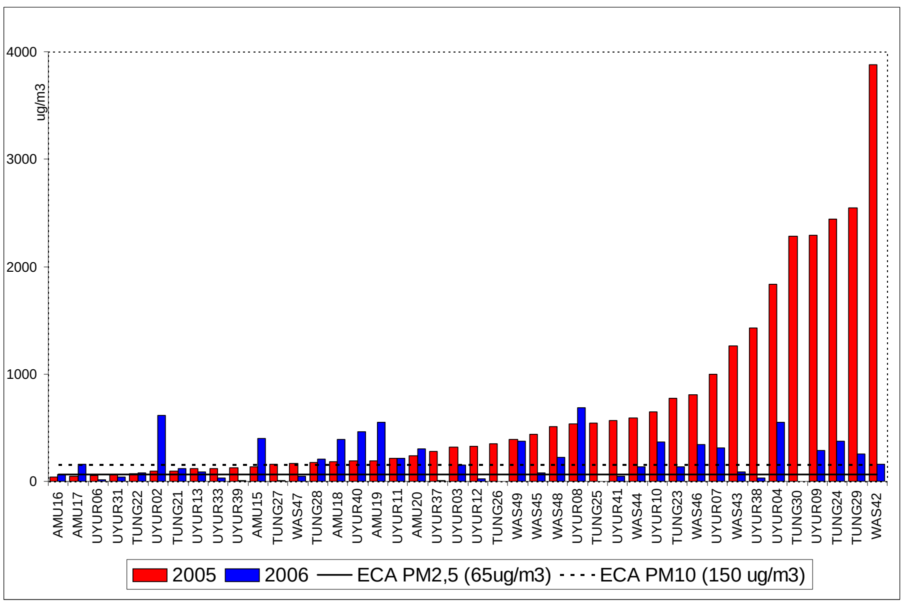

Figure 5. 24h PM_4 concentration in µg/m3 before (2005) and after (2006) installing improved stoves, by household identifier codes

Figure 4 shows the significant decline in overall average PM_4 concentrations before and after installing the improved stoves. **Figure 5** shows the significant difference between the highest PM_4 concentrations recorded before and after the intervention by household. While the maximum recorded value in the baseline sampling was 3,880 µg/m^3, the maximum recorded value post-intervention was only 688 µg/m^3. The 2005 peak value was reportedly in a kitchen with no ventilation, where three meals/day were cooked, and the cooking time was longer than average (five hours, compared to the average of four hours). It is unclear whether additional factors would explain this extreme particulate concentration. The 2006 peak value was recorded in a kitchen where a pot smaller than the stove's hole was used, leaving room for smoke to escape into the kitchen. Even so, the maximum post-intervention PM_4 value recorded is up to five times lower than the maximum level recorded in the baseline. Note that "ECA" is the Spanish acronym for Peru's ambient air quality standards. As mentioned earlier, although substantial reductions were achieved in the majority of households, some households had fairly low baseline levels but higher post-intervention levels. This chart reveals these results clearly.

The IAP analysis included examining the relationship between concentration levels and the number of meals cooked and the type of roof ventilation in the home. The importance of both these factors became apparent following the baseline monitoring. The monitoring took place during a harvest period, when many families were in the fields during the day and no cooking took place in the kitchen at lunchtime, thus eliminating a mid-day pollutant peak, which may be part of the reason for higher readings after stove installation in some homes. Other possible factors include deteriorated stove elbows, changes in user behavior that exacerbate smoke levels (such as leaving the stove burning all day to avoid having to re-light it at mealtime), mismatches between pot and burner sizes, and a lack of proper stove and chimney maintenance. Further discussion of these issues is included in **Annex IV**, which covers reporting by Swisscontact on the IAP monitoring.

As for the ventilation parameters, Winrock observed during a pre-intervention field visit that some homes had created a roof escape for smoke. Some households had rudimentary holes cut out above the ground-level open fire, while others had very carefully designed hoods placed over elevated cooking platforms, leaving only a couple of feet between the open fire and the hood. The baseline monitoring confirmed that the average contaminant level in the homes with hoods was less than half the level in homes with simple openings, and less than a third of the level in homes with no roof openings. Even with hoods, however, the average indoor concentrations exceed guideline values.

Unexpected Result: New Kitchens

Among the unanticipated findings was that a significant portion of homes decided to construct a new kitchen area for the Inkawasina stove, leading in most cases to a larger space with better ventilation. These factors likely contributed to reductions in IAP concentrations. Anecdotal statements from women indicated that if they got a new, cleaner stove, they wanted a new, cleaner kitchen as well. Some families in Inkawasi delayed the installation of the new stove until a new kitchen space was constructed. A Winrock partner in Central America, Proleña/Nicaragua, has observed similar behavior. The delays in stove installation—and in some cases of the IAP monitoring—were outweighed by the positive impact that these kitchen improvements represented for Inkawasi women and their families. These improvements were strong indicators of the value families placed on their new stoves, and the commitment they were prepared to make to create and maintain a healthy kitchen environment.

Based on the second post-intervention monitoring, which shows less dramatic reductions as well as some significant IAP increases, Winrock concludes that there is a need to address possible weaknesses in the ceramic elbows and an even greater need to reinforce messages about effective (and counter-productive) behaviors to achieve the substantial IAP reductions demonstrated in many project households.

6. Other monitoring: practices, perceptions, and health symptom measurements

To gain insight into the project's achievements and constraints, in December 2006 Winrock staff conducted three focus groups in Inkawasi with 56 members of the beneficiary communities throughout the district, including new stove owners as well as those who did not own stoves. The focus groups were based on a set of 20 questions designed to prompt participants to speak out on all aspects of the project, specifically: 1) by which communication means they had learned about IAP; 2) their present level of awareness about IAP; 3) their level of satisfaction with the stoves; 4) difficulties they encountered with the animal modules; and 5) their overall perceptions of project implementation by the EHA. The focus groups were conducted by a local teacher in Quechua, through open questions to the groups in a dialogue format, while Winrock staff made notes following translation of the answers into Spanish.

Focus group meeting in Rio Pampa, facilitated by a local Quechua-speaking teacher.
Photo credit: Winrock International

In early July 2007, Centro ECO staff conducted another round of consultations using the same questions through two approaches: one focus group discussion in Spanish with 25 project promoters; and a quick survey of 36 households (18 households with stoves and 18 households that did not participate in the project). The households surveyed were in the communities of Rio Pampa, Sukchapitej, Huasicaj, Chumbeaura, and Sinchihual, and the questions were posed with the help of a Quechua translator.

Practices and perceptions

The baseline household-level survey to gather information about cooking practices and health perceptions of Inkawasi households included 88 questions and took approximately 45 minutes to administer. For the post-intervention survey, Centro ECO eliminated several questions judged to be least useful, thereby shortening the time burden on families participating in the survey.

The sample for the pre-intervention survey was a randomly selected 169 households. Of this number, 166—nearly 6% of the district's total number of households—participated in the follow-up. Centro ECO trained a local team to administer the survey.

Annex V includes detailed results of the household cooking practices and perceptions survey. The feedback led to the following primary conclusions:

- Before the Healthy Kitchen/Healthy Stove project raised awareness about indoor smoke, the perception among Inkawasi housewives was that IAP was "the way life is," and they had no hope of changing the situation.
- Overall, the communities were happy with the Healthy Kitchen/Healthy Stove project, which had significantly improved the quality of life among beneficiary families. The main benefits mentioned were much less smoke in the kitchen, savings of firewood and time, having a modern stove, and, consequently, improved family health.
- In general, the beneficiary families were more aware of the health risks of being exposed to wood smoke, and they now sought to minimize and restrict the use of open fires indoors, using open fires only outdoors for special occasions.
- The ways to reduce IAP exposure mentioned by most people included buying an Inkawasina stove, opening windows and doors, making kitchens larger, and keeping children out of the kitchen to the extent possible.
- The participating families found it relatively easy to comply with the requirements of the project (repaying the loan and modifying their cooking practices).
- Raising the animals was very interesting to the families, both as a potential additional source of food, as well as a valuable good that could be exchanged for other products or sold to obtain money in moments of necessity.
- However, mortality among the animal modules was relatively significant; beneficiaries acknowledged that this problem was due in large part to their own carelessness about the animals' health, and they desired more assistance with animal care.
- Focus group participants reported that the 10-12 month loan repayment period was too short, especially given that the ducks were slow to breed and some animals were occasionally stolen, or eaten by other animals. These groups recommended that the time period for completely repaying the loan (240% repayment) be extended to between 12-18 months.
- The main suggestions for improving the stoves included making different sizes of pot rings to accommodate different pot diameters, making a bench of adobe so the cook could rest, making a tray to collect the wood ash, and building stronger ceramic elbows.
- The families revealed that they could easily recognize the stove makers within their communities.
- Many families had not yet engaged in the project because they had not been directly approached and informed by an EHC promoter, although they had heard of the project through a friend, a family member, or even the radio. Some of them felt uncomfortable about making a commitment to borrow the capital through an animal module.

Assessing lung function in one home.

Photo credit: Centro Eco

Health symptom monitoring

Although exposure to smoke from the burning of biomass fuels is known to be associated with death and disability, the degree to which exposure must be reduced to prevent respiratory ailments is still unknown. To explore this question, health symptom and lung function data (FEV1%—a frequently used spirometry measure to assess airway obstruction) were collected from individuals in households before and 15 months after installation of the Inkawasina stoves to complement the collected IAP data. (This was not a core component of the project, which lacked the funding to do a full health impact study, and the data is indicative only.)

Before stove installation, spirometry data were obtained from 82 individuals from 49 households where stoves were to be installed. Of these 82, 57 test results were valid and met the criteria for reproducibility. However, valid test results could be collected from only 17 of these individuals 15 months after stove installation. Also, two of these individuals lived in households where IAP monitoring was not done both before and after installation. Therefore, only 15 individuals had FEV1% spirometry data meeting all test validity criteria and complete IAP results.

Extrapolating from a recent study on the impact of ending exposure to tobacco smoke, the study team predicted that reduced exposure to cooking fire smoke would lead to a 2.78% average increase in FEV1% in the follow-up period. Surprisingly, FEV1% among the 15 valid observations *declined* by 1.38% rather than increased. However, there were marked differences in IAP reduction in the households of these 15 persons.

By dividing the 15 observations into two groups–those with good respirable particulate reduction (defined as reductions over 64% *and* post-installation concentrations under 100 μg/m3) and those with poor particulate reduction–and removing two outliers, Winrock found that the change in FEV1% was significantly better ($p < 0.01$) for persons in households with good IAP reduction. Furthermore, while the 95% confidence interval for the mean change in FEV1% was large, it was entirely positive for those with good particulate reduction and included the hypothesized 2.78% improvement.

Detailed results of health symptom monitoring are found in **Annex VI**. These results supported Winrock's general hypothesis that individuals in households that greatly reduce respirable particulate exposure from cooking smoke will have less progression of chronic lung disease. Much more extensive and rigorous study would be needed to relate such exposure reductions to decreased incidence and severity of acute lower respiratory tract infections in infants and small children.

III. KEY OBSERVATIONS AND LESSONS LEARNED

The Winrock team made a number of observations and formulated the following lessons learned about the Healthy Kitchen/Healthy Stove project through ongoing discussions with the Centro ECO team; several field visits to Inkawasi, including interviews with households; Centro ECO's household surveys; the IAP monitoring conducted by Swisscontact; and focus group discussions with the project promoters and beneficiary families conducted by Winrock and Centro ECO.

The Inkawasina culture is very socially oriented. Here, after a promoters' meeting with ECO, participants share their food in a community meal. *Photo credit: Winrock International*

A. Reduction of Indoor Smoke

This project model substantially reduced indoor air pollution with the Inkawasina stove and improved cooking practices. The monitoring results showed that, on average, the intervention reduced IAP levels by 70%, clearly demonstrating the intervention model's potential to achieve significant reductions in IAP exposure.

The final post-intervention round of IAP monitoring in July/August 2007 made clear, however, the importance of quality control of stove components and of the cooks' fuel management practices. Without close attention to production quality and reinforcement of key stove usage behaviors, much of the smoke reduction achievable with proper stove performance can be lost.

B. Establishing Local Institutional Capacity

Despite the challenges of working in a cash-poor region with low literacy rates, the ECO staff and the communities of the Inkawasi district demonstrated remarkable leadership in embracing the objectives of the Healthy Kitchen/Healthy Stove project and corresponding responsibilities. Winrock believes community initiative and leadership are important indicators of a strong enabling environment for future replication of this model in similar communities.

- Centro ECO's previous community organizing experience proved critical in motivating community leaders and creating a trusting relationship between the NGO and project promoters. Future project implementation should seek to incorporate similar solid experience with community organizing.

- Personal connections within the district facilitated access to households. The lead technical engineer was born and raised in Uyurpampa and not only spoke the local language and knew many families, but was intimately familiar with daily life and customs. Future initiatives should aim to involve one or more champions from within the target population.
- Pride, status, and the opportunity to learn and improve community conditions were strong motivators for promoters to become active in the project. Interested and committed individuals were not hard to identify. It appears quite possible to engage indigenous rural communities from this region in volunteer work to promote projects with a social focus. Sufficient training must be provided, however, to ensure that promoters have absorbed the messages and gained the skills needed for proper management of all project components.
- Expanding the project's geographic scope to maximize the number of communities risked spreading project administration and associated resources too thin. Establishment of more EHCs should be resisted until the existing structures have demonstrated that they can operate autonomously. Future efforts should avoid too much breadth before sufficient depth of involvement is established in each participating community, and behavior change, technical promotion, and micro-credit activities are working satisfactorily.
- Demonstrated community leadership and initiative are important indicators of a strong enabling environment for future replication of this model in similar communities.

C. Raising Awareness and Changing Behaviors

The social communications campaign conducted in Inkawasi appears to have been effective in educating the majority of families engaged in the project about the risks associated with indoor smoke and convincing them to adopt new practices and behaviors that reduce exposure.

Messages about healthy kitchens have also been passed to children, who are the main beneficiaries of the new behaviors and practices.
Photo credit: Winrock International

- Direct promotion through household visits has been very effective in raising awareness, motivating participation in the project, and prompting behavior change. The simple, locally oriented educational materials developed for use by the promoters were useful tools for communicating key messages.

- Many families voluntarily invested time, resources, and ingenuity to improve their kitchen environments to complement the improved stove, from installing shelves to constructing completely new kitchens. This level of commitment suggests that the improved stoves are highly valued, and that this population is eager to invest in improving its living conditions.

D. Establishing Micro-Loans for Cash-Poor Communities

The micro-loan mechanism based on animal husbandry has been perhaps the most innovative aspect of this project, but also proved the most challenging. This financing approach has drawn attention from many other development organizations interested in learning how it works and how the model could be applied in other poor rural communities throughout Latin America.

This type of non-monetary micro-finance system is well suited to the local trading customs of cash-poor populations, including the Inkawasi, and appears to offer a long-term mechanism for household-level income generation. However, the system requires a significant amount of local capacity building before it can be implemented successfully. The lessons identified here are currently being addressed by community leaders in coordination with Centro ECO.

- As participants were dependent on animal reproduction rates to pay back their loans, overall financial planning was more difficult in this non-monetary model—for both the loan administrator (in this case ECO and the EHCs) and the borrowing families—than in a strictly cash-based model.
- The micro-loan system was hampered by the high rate of late animal module payments. In turn, stove dissemination was slowed down to reduce the impact on cash flow within the loan fund. To avoid cash flow bottlenecks and ensure a sustainable finance mechanism, greater attention should be paid during project planning to the key factors influencing animal reproduction rates.
- Ensuring success with animals requires both that appropriate animals be selected (i.e., of appropriate species and stock), and that adequate veterinary training be provided to project promoters as well as to borrower families. Judgments on the appropriate animals for a micro-loan program in a specific community should be left to veterinarians with experience in the target area.
- Tracking of module payments should include the total numbers of animals repaid (and their

Guinea pig husbandry is well known by the families of Inkawasi, although training in better care techniques is needed to improve growth and survival rates.
Photo credit: Winrock International

monetary value), as well as the number of families who have repaid entire modules.

- The mechanism should incorporate a late fee penalty as a motivator for better animal care and quicker repayment.
- Local loan managers require solid training to ensure they have sufficient skills and understanding of factors affecting repayment. Achieving repayment goals will be greatly facilitated by working with an implementing partner with strong business sense and skills.
- Realistic milestones should be set for future projects to enable proper evaluation throughout all stages, and allow for corrective actions sooner to avoid compromising the sustainability of the animal micro-loan fund.

E. Introducing Appropriate Technology

The Inkawasina wood stove has proven to be a suitable model for the Inkawasi population. It is affordable, uses primarily local materials, is more energy efficient than traditional open fires, significantly reduces indoor smoke, and is accepted and liked by local families. The commercialization strategy established in Inkawasi with a network of stove makers and ceramic artisans has been responsive to local needs and to the demand for stoves from the Inkawasina families.

- Additional IAP reductions of 5-15% could be achieved with modest improvements to the stove design, combined with attention to occasional installation flaws (e.g., short chimneys) and reinforcement of basic behavior changes (e.g., covering pot holes when not in use). Although some of these adjustments involve minor additional effort, others involve higher costs, such as metal griddles and more intense promoter follow-up on end-use behaviors.
- Ceramic elbows have been notorious for cracking in stoves in a number of countries. Though cracking does not necessarily result in reduced performance, this factor should receive close attention and follow-up. Producing fool-proof stove components requires continued research for appropriate local solutions; solid training of local artisans; adequate materials; and training and technical assistance in construction of local kilns. Follow-up by Winrock and Centro ECO with the ceramic artisans has led to more rugged elbows for Inkawasi, which can also be offered to residents of Ayamachay to rehabilitate their stoves. Careful follow-up should be undertaken to ensure that the elbows in Inkawasi continue to permit satisfactory stove performance. In the meantime, Winrock and Centro ECO should continue their research efforts and seek opportunities to incorporate tips from other projects on more robust ceramic “recipes” to improve elbow performance.
- Stove users must be made aware of the stove weaknesses and limitations and receive reinforced training on proper use of the stove. With time and experience, users will understand the importance—and efficiency benefits—of feeding the combustion chamber carefully.

- A design modification to accommodate varying pot diameters will significantly improve the ability of the Inkawasina stove to reduce IAP more consistently. A one-size pot hole approach cannot fit all families. Winrock has given ECO more flexible options to consider and experiment with, to better accommodate different family needs and pot sizes. These options can be complemented by a greater focus on educating families about using a reduction ring or cooking over a pot hole covered by a metal sheet.

F. IAP Monitoring

As indicated earlier, the Healthy Kitchen/Healthy Stove intervention achieved substantial average reductions in indoor smoke. The reductions can be expected to surpass the targeted 80% reductions with the correction of installation flaws and cracked elbows in some households and more effective use of the stoves.

Winrock considers this degree of smoke reduction to have significantly improved the lives of Inkawasi families, including notably reducing health symptoms aggravated by smoke exposure. Winrock recognizes, however, that claiming the project has achieved specific health outcomes, such as a reduced incidence of infant pneumonia or of COPD among women, would be premature. A complex, long-term, and prohibitively expensive study would be required to support such claims. Nevertheless, Winrock believes the IAP monitoring was worthwhile for establishing a relative measure of pollutant reduction achievable through this intervention. This measure will enable comparison with similar interventions around the country and with improvements to the Healthy Kitchen/Healthy Stove model, as they occur.

The actual IAP monitoring process also revealed some specific areas of concern:

- Despite the involvement of a strong analytical partner experienced in ambient air monitoring, the partner still needed time to become familiar with IAP protocols and monitoring equipment.
- The monitoring equipment is not fail-safe, and requires special considerations (e.g., battery charging) for use in remote settings where electricity is unavailable or unreliable. The PM monitors were not designed to measure such extreme levels of particulates and sometimes clogged in less than 24 hours. Equipment failures in the field can cause significant delays in monitoring. Despite local capabilities to clean, repair, and recalibrate this equipment, the extreme conditions in which it is used may lead to premature failure, at which point Peruvian groups will need to decide whether to invest in new equipment for future monitoring.
- The variation of stove installation dates within the sample likely led to misinterpretation of the data, and in this case may have led to lower estimates of the intervention's ability to reduce indoor concentrations of particulates and CO. Future projects should aim to coordinate installation of the stoves in the households to be sampled within a short window (e.g., within a month of one another).

- At a minimum, follow-up monitoring should be conducted 12 months following the installation date; if budget and logistics permit, pre-and post monitoring during another season (e.g., the rainy season, six months apart from the dry season) would be even better.
- In addition to confirming the potential of the Inkawasina stove to achieve substantial (>80%) IAP reductions, the monitoring was valuable in detecting common problems with stove use and prompting follow-up solutions and innovation to mitigate the problems, such as using metal plates to reduce smoke leakage between pots and pot holes of unequal size. The monitoring also indicated the importance of user experience in influencing a stove's performance, and impact on both smoke production and leakage.

G. Other Monitoring: Household Practices & Perceptions and Health Symptom Monitoring

Winrock aimed to gather enough useful data before and after the intervention to detect changes in household cooking practices and perceptions about specific health impacts resulting from the intervention. Winrock envisioned integrating some of the household survey data with the IAP data and, if possible, the health symptom data, to form an even more complete picture of changes brought about by the Healthy Kitchen/Healthy Stove project.

These expectations were too optimistic for a project of this scope. Adapting the survey for the Inkawasi context was itself a time-consuming task, requiring multiple translations and adjustments after the initial field trial. ECO faced time constraints while training a survey team, which in turn led to less than full confidence in the results. Because of Swisscontact's experience with data management and statistical analysis, Winrock charged the team with integrating the household and health symptoms data with the IAP data. However, significant delays in the processing of household and health data rendered such integration infeasible. Departure of key ECO personnel exacerbated these delays, reducing the time available to review and discuss the results.

- Though the tight budget led Winrock to keep the household survey in-house (administered by ECO), it ultimately might have cost less, detracted less from ECO's principal implementation responsibilities, and yielded more valid results had this task been contracted out to an experienced team of field researchers. This would also have reduced any possibility of a bias factor influencing the monitoring results and analysis.
- Although the health symptom monitoring was not a core component of this project, spirometry tests may be worth conducting on a larger scale to assess an intervention's impact on lung function among adults. If such an activity is planned, however, the research team should demonstrate fluency with local languages, expertise in COPD and statistical analysis, and adequate familiarity with local customs and potential barriers to conducting these medical tests. Moreover, any health symptom survey should be peer reviewed and field tested before final application.

H. Dissemination of Project Model

Winrock has sought numerous opportunities to disseminate information on the Healthy Kitchen/Healthy Stove project model to targeted audiences throughout the course of the project. Project partners collaborated on several occasions to make presentations on the project's approach and results, to share the experience with other implementing groups, and to increase visibility of indoor air pollution and mitigation measures. These dissemination events included:

Participants at the seminar on IAP and stoves, jointly organized by PAHO and Winrock in Lima, December 13-14th 2006. *Photo credit: Winrock International*

- September 2005, Lima, Peru: Healthy Housing Initiative seminar, sponsored and organized by WHO/PAHO. Winrock presented on overall IAP and environmental health integration model development for both Peru and Bangladesh; Centro ECO presented the methodology and overall project status; and Swisscontact presented the IAP monitoring plans.
- January 2006, Seattle, USA: ETHOS[21] conference. Winrock presented project methodology and status.
- October 2006, Brasilia, Brazil: First Brazilian IAP and Improved Stoves seminar, sponsored by USAID/Brazil and Shell Foundation, and co-organized with Winrock International. Winrock presented project methodology and status.
- December 2006, Lima, Peru: IAP and Health seminar. Winrock initiated and co-organized this event with PAHO. Centro ECO presented an update on the results of the stove dissemination and micro-credit system, while Swisscontact presented preliminary results of the reductions achieved in IAP.

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[21] ETHOS (Engineers in Technical and Humanitarian Opportunities of Services) is a non-profit organization that holds annual meetings among stove and IAP experts from around the world to discuss the latest advancements in stove technologies, IAP monitoring, and related issues. The presentations from the meetings can be downloaded from http://www.vrac.iastate.edu/ethos/proceedings.php.

- January 2007, Seattle, USA: ETHOS conference. Winrock presented the preliminary IAP monitoring results.
- February 2007, La Paz, Bolivia: GTZ sponsored an improved cookstoves workshop. Winrock presented the micro-loan animal modules scheme as a way to finance improved cookstoves.
- March 2007, Bangalore, India: 3rd Biennial Partnership for Clean Indoor Air Forum. Winrock presented a poster on the preliminary IAP monitoring results.
- June 2007, Managua, Nicaragua: Central American Wood Energy and Improved Stoves Meeting. Centro ECO presented the project approach and overall results.
- Publication of the project's baseline IAP monitoring results in the World Bank's Country Environmental Analysis report, which assesses the costs to Peru of indoor air pollution, among other factors of environmental degradation.[22]

Each of these events and discussions has generated significant interest in the Healthy Kitchen/Healthy Stove model. The components of this model that stand out when presented alongside other projects are the efficiency and smoke-reducing aspects of the stove design (i.e., the incorporation of rocket stove design principles); the inclusion of indoor air pollution and health risks in education and awareness-raising materials; and the micro-credit scheme that increases access by the poor and offers an alternative to ineffective and unsustainable subsidies.

Within Peru, the most significant event was the December 2006 seminar specifically focused on household energy, IAP, and health. Winrock engaged PAHO/Peru in organizing this seminar, which brought together–for the first time in Peru–several key actors engaged in stoves and/or indoor air pollution and health issues. Three contractors of the USAID/Peru mission also participated: Caritas and ADRA, which spoke about dissemination of improved wood stoves within the PL-480 food security program in Peru; and Management Sciences for Health (MSH), which spoke about stove dissemination through the Healthy Municipality project under USAID/Peru's health program.[23]

Among the notable outcomes of the event were the following:

- PAHO was particularly impressed by the IAP monitoring results and has since committed to IAP monitoring of a 3,000-household project it is initiating in Cuzco with Japanese funding. For this monitoring, PAHO contracted Swisscontact to train a staff member and facilitate field measurements and analysis, with equipment borrowed from USAID/Winrock.
- Peru's First Lady, Mrs. Pilar Nores de García, took great interest in the Inkawasina stove model and the micro-credit scheme. In 2006, the First Lady became very active in promoting the SEMBRANDO program, a major high-profile initiative targeting marginalized, high-Andean indigenous communities.

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[22] Republic of Peru Environmental Sustainability: A Key to Poverty Reduction in Peru. Country Environmental Analysis. June 2007. Report 40190-PE, The World Bank.

[23] Presentations given at this seminar can be downloaded at http://www.per.ops-oms.org/talleres.html.

SEMBRANDO has since formed a partnership with Centro ECO and Fondo de las Américas (FONDAM[24]) to expand the dissemination of Inkawasina stoves throughout the Inkawasi district, and also with other NGOs that participated in the seminar.

- GTZ invited Winrock to present the animal micro-loan scheme at its February 2007 seminar in La Paz, Bolivia, and the Ministry of Mines and Energy of Nicaragua invited Centro Eco's stove engineer to present the stove technology at its June 2007 meeting in Nicaragua.

Winrock has worked with Centro ECO to explore ways to replicate and scale up the Inkawasi experience. ECO successfully negotiated with FONDAM and SEMBRANDO to replicate the Healthy Kitchen/Healthy Stove project in six other communities of Inkawasi. ECO has also worked with private entities to further dissemination activities, including the construction of around 300 stoves to date along with home rebuilding in Chinca, south of Lima, which was devastated by a 2007 earthquake.

I. Considerations and Recommendations for Replication and Scale up

The integrated household energy, indoor air pollution, and health intervention model piloted by the Winrock/Centro ECO team in the Inkawasi district shows promise for self-replication throughout the district, as well as replication on a greater scale elsewhere in Peru and the high-Andean region. Winrock suggests the following factors warrant careful consideration in replicating this model.

1. The integrated model

Based on the Healthy Kitchen/Healthy Stove experience, complementing technology intervention with a market-based approach, multi-media communications, and a strong team of local promoters is appropriate and effective for long-term adoption of cleaner and more efficient cooking technologies and practices in Peru, particularly where indoor smoke is a chronic problem. Integrated models are by nature more complex than simpler, single-faceted interventions, however, and thus require more investment in up-front planning and training.

2. Factors for success

At a minimum, the following factors are critical to replicating the Healthy Kitchen/Healthy Stove intervention model:

- A solid local champion to lead the intervention with experience and credibility in the project region; strong project management experience and accounting and communications skills; and, preferably, experience and skills in small business management.

[24] FONDAM: Fund of Americas, a grant award organization which was jointly created by the US and Peruvian governments.

- Clear and reasonable milestones for accomplishing objectives, and enough time to make adjustments to reach the overall project goals.
- A dynamic, motivated project manager or key technical advisor based in the field who can lead the project or provide valuable support in the field and be responsive to the interests of the donor, and provide clear project guidelines.
- Up-front training of savvy community leaders who can manage the project at the community level, and who share a business vision for financial sustainability to ensure greater benefits to the communities.
- A skilled veterinarian with experience in the project region.
- Field-tested communications materials, with emphasis on pictorial materials for end-user training.
- An in-depth promoter recruitment and training program, phased such that promoters are well-versed in the topics prior to installation of the first stoves, and sequenced with some repetition and review to accommodate new recruits, reinforce learning, and update knowledge as promoters become familiar with user preferences and complaints.
- An in-depth elbow and stove builder training program, phased such that artisans are adequately skilled prior to installing the first stoves.
- Access to good clay and adherence to the best-known local "recipe" for durable ceramic elbows.
- A micro-loan system that utilizes animals appropriate for the region and starts with good stock. There must be an existing market for these animals, moreover.

3. Constraints

The lessons learned from this project suggest that there are some areas that need special attention. Some of the constraining factors affecting the progress of the Healthy Kitchen/Healthy Stove pilot project include:

- A high reliance, at least in the early stages, on direct promoter outreach, which implies significant investment in promoter training and follow-up, as well as a limit to the rate at which households can be reached for a given density of promoters.
- Limited knowledge of and experience with financial systems among target populations and communities.
- A payback system dependent on animal reproduction rates, which can be variable.
- Lack of motivation to repay loans among communities with a legacy of subsidized projects.
- Remoteness of communities, lack of communications infrastructure, and absence of housing for visitors.

The approach this project took was very successful in raising awareness about IAP and health impacts, creating demand for improved stoves, establishing a sustainable market for the stoves, and developing a sustainable micro-credit model for stove payment. The reductions in IAP in target homes was lower than expected for a variety of reasons, including deteriorated stove elbows, changes in user behavior that exacerbate smoke levels (such as leaving the stove burning all day to avoid having to re-light it at mealtimes), mismatches between pot and burner sizes, and possibly a lack of proper stove and chimney maintenance. Future interventions should aim to replicate the awareness raising, capacity building, market development, and micro-credit aspects of the Healthy Kitchen/Healthy Stove pilot approach, with additional attention to the factors noted here, including the need to reinforce messages about effective (and counter-productive) behaviors to sustain the substantial IAP reductions demonstrated by this intervention.